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The

Tropical Agriculturist

APRIL—JUNE, 1945

EDITORIAL

CITRUS CULTIVATION

BEHIND the stock-scion experiment for citrus that is described elsewhere in this periodical lies the story not merely of the progress of a series of trials but the disturbing failure of a much more fundamental one.

The desirable qualities of citrus fruit led to the expansion of its cultivation from its original home in the tropics even towards temperate regions beyond the frost line. In those unusual surroundings, it acquired a certain mellowness of its desirable qualities which enhanced its popularity and gave an additional impulse to its cultivation. Not least among the circumstances that led to the improvement of its qualities in those temperate regions were the care and attention paid to its culture and selection. Later, the recognition of its high nutritive value, following on the discovery of vitamins, was another contributing factor.

In Ceylon, orange, mandarin and lime trees had led a neglected and precarious existence in backyards, in competition with other trees ; and not a fraction of the care that these valuable trees were rightly entitled to was devoted to their development. In the late twenties, however, Ceylon, like some other tropical countries, became suddenly alive to the possibilities of citrus cultivation as an economic crop. Immediately, grafted varieties of diverse kinds were imported from all parts of the world—from California, Florida, Palestine, Australia and South Africa, and planted indiscriminately with little thought of scientific management. Somehow, the idea seems to have existed that, as the tropics were the home of the citrus, any varieties that did well in other climes would do even better in their original home. This was the first experiment—the experiment that failed. Fortunately, very few imported these varieties on a large scale, so that, ultimately, the net loss was distributed among a large number of fruit growers. The results, however, were very disappointing. Many of the imported varieties produced fruit with undesirable qualities, and even the bearing life of most of them did not extend to more than eight years. It took some years, of course, before fruit growers realized, to their dismay, that the importation of foreign varieties did not provide a short cut to success ; and before they recognized that the problems of selection, propagation and cultivation had to be worked out *ab initio*, for each horticultural zone in the country. The recognition of this was the beginning of the second experiment—the experiment that is

little by little proving to be a success. Already, the Vavuniya and Bibile areas have come to be regarded as the most suitable for citrus cultivation and the possibilities of North Matale, Middeniya and Embilipitiya are under observation. Selections from local parent trees have given a very useful orange and a mandarin, and it is more than likely that they will be recognized as two strains of outstanding performance in the near future. Cultural practices—different ones for different areas—are gradually getting established. The article now under consideration takes us to the point to which progress has been made in methods of vegetative propagation.

ORIGINAL ARTICLES.

STOCK-SCION INFLUENCE IN CITRUS

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IN most countries where citrus is grown on an orchard scale the commercial method of propagation is by budding the desired scion variety on a compatible stock which can be easily raised from seed. The seedling stocks are grown in nursery beds and budded almost exclusively by the inverted T method of budding.

Budgrafts propagated vegetatively by this method on genetically uniform stocks will nearly always come true to type and bear earlier than seedling trees of comparable age. They tend to be uniform in growth and are easy to train in the orchard. They will produce fruit of uniform quality, and if they are the progeny of buds selected from inherently high yielding trees they will tend to give uniformly high yields. Their comparatively low spreading habit of growth facilitates spraying, pruning, thinning and other cultural operations in the orchard.

Seedling trees on the other hand tend to grow tall and erect and with few exceptions cannot be depended upon to breed true to type owing to possible cross pollination with other citrus varieties. Plants raised on their own roots as layers and gootees are often planted in village gardens, but the method of raising them is slow and cumbersome.

In the case of a budgraft the scion has the further advantage of being on a root stock which is probably more resistant than the scion itself on its own roots to pests and diseases and to unfavourable soil and weather conditions brought about by drought, frost, excessive rainfall &c. In a compatible stock-scion combination the stock will tend to influence the growth of the scion, its yield and fruit quality, while the scion will tend to have a similar reciprocal effect on the root system of the stock (Hodgson *et al.* 1937).

With most deciduous fruit trees a stock-scion combination which is a failure in one place is generally so in most other places regardless of environmental influence, indicating thereby that the failure is mainly due to physiological and structural differences between the stock and scion. But in the case of citrus the problem of stock-scion incompatibility is more complicated, since a stock-scion combination which does well in one place may be a complete failure in another owing to differences in environment. A striking example of this is the behaviour of the sour orange which makes a good stock for sweet orange on a commercial scale in California, Florida and Palestine but is a failure as a stock for sweet orange in South Africa, Java, and Peshawar, although when left unbudded it makes vigorous growth and crops well [Webber (1926), Toxopeus (1936), Brown (1920)]. The position is well described by Professor V. A. Blackman (1937) in a statement that

" the success of a graft like that of a marriage may depend not only on the inherent qualities of the two individuals but also on the conditions, favourable or unfavourable, to which they are exposed during their partnership ".

There are in Ceylon wide regional variations in soil and climate which make it necessary to carry out stock-scion trials with local and imported varieties in order to develop a suitable stock-scion combination for each region. Prior to the war citrus grafts were imported in large numbers mainly from Australia and South Africa and planted in various parts of the Island, but it soon became evident from the performance of these trees that many of the stock-scion combinations were not suited to local conditions. It was felt that some of these varieties were likely to do well if they were budded on local acclimatized stocks.

The experiments which form the subject of this paper were laid down under different soil and climatic conditions in the wet zone at Peradeniya in November, 1936, in the semi-dry zone at Nalanda in February, 1938, and under irrigation in the dry zone at Hingurakgoda in November, 1941, with a view to test the suitability of different stock-scion combinations in regard to their (*a*) general habit of growth and vigour, (*b*) yield and quality of fruit, (*c*) resistance to pests and diseases.

In the grapefruit stock-scion experiment at Peradeniya where the average annual rainfall is 93·5 inches there are four different stocks—Rough lemon (C. *jambhiri*. Lush), Sour orange (C. *Aurantium* L), Pummelo (C. *Maxima* Merr.) and sweet orange hybrid (C. *sinensis Hybr.*) budded with four different grapefruit varieties—Walters, Marsh seedless, Triumph and Foster. The soil here is a light loam of low fertility. A preliminary report on this trial has already been published (Richards 1938).

In the grapefruit trial at Hingurakgoda Farm where the average annual rainfall is 78 inches there are two stocks—Rough lemon and sour orange—budded with four varieties, Walters, Marsh seedless, Cecily seedless and Triumph. The experimental area is in a low lying section of the orchard which is subject to water logging during a continuous spell of wet weather. The soil is a medium loam about 3 ft. in depth, overlying partially weathered igneous rock.

Sour orange and rough lemon are used as stocks for three imported orange varieties—Mediterranean sweet, Valencia late and Navalencia, and two local varieties, Vavuniya and Katugastota orange, in the trial at Nalanda experiment, and for Valencia late, Vavuniya, Bibile and Indian sweet orange at Hingurakgoda.

The same two stocks are used for Nagpur Santra, Beauty of Glen Retreat, and Emperor Mandarins in the stock-scion trial at Nalanda where the annual rainfall is 83 inches. The soil here is a medium loam of variable depth overlying magnesium lime stone or dolomite from which it is derived. It contains in sections a high proportion of iron nodules.

THE ROOTSTOCKS

Rough Lemon (C. *jambhiri* Lush.). The Rough lemon grows well on light sandy soils under conditions of low rainfall, and is used for that purpose on a commercial scale in parts of Australia, Florida, India and S. Africa where according to Marloth (1938) it is the only stock used. In Ceylon this varietv

is found in home gardens in the Jaffna Peninsula where it is known in Tamil as *Narathai*, but it occurs only rarely in other districts where its origin can often be traced to imported grafts in which the scion had failed.

The ordinary tubercled lime or *Kudaluthehi* (C. *hystrix*) and *Nataran* a variety of citron (C. *medica*), both of which are slow growing and unsuitable as stocks, are often mistaken for rough lemon because of the rough appearance of the fruit, but their foliage is strikingly different from that of the rough lemon.

The rough lemon seedling has a deeply penetrating taproot and fibrous laterals which are well adapted to forage in the fertile top soil. It can stand drought conditions better than most other stocks. It is inherently a vigorous grower, and is invigorating in its effect on the scion especially in the early years. Fruits produced on this stock during the first few years are generally coarse and not up to standard in quality.

The variety is more resistant to collar rot or gummosis than most other stocks with the exception of sour orange which is highly resistant. It is very susceptible to citrus scab and to a lesser extent to citrus canker.

Sour Orange (C. *Aurantium* L.). The sour orange was until recently used almost exclusively as a stock for citrus in California. It is a popular stock for use on wet and heavy soils in Florida, Texas, Arizona, Palestine and the Southern states of Australia, since it is highly resistant to foot rot. According to Hume (1930) about 75 per cent. of the world's commercial output of citrus fruit is from trees grown on this stock.

Many strains of sour orange are known to exist of which Bitter Seville is the strain commonly used in California. Baker (1938) has reported the existence in Trinidad of certain poor strains of sour orange which, though resistant to foot rot, are susceptible to other forms of root disease. The Ceylon sour orange or *Ambuldodan* grows well in village gardens in the wet zone and produces a fruit which is valued for its medicinal properties.

The sour orange seedling is not so vigorous in growth as the rough lemon and is reputed to be semi-dwarfing in its effect on the scion. It has a strong root system with a tap root which when severed in transplanting produces several deeply penetrating roots from near the cut end.

Sweet Orange Hybrid (C. *Sinensis* hybr.). The sweet orange is more susceptible to gummosis and other root diseases than sour orange and for that reason it has not been used extensively as a root stock. With improved irrigation and cultural practices the danger of loss through gum diseases has diminished and the stock has in recent years come into favour in California and Australia since trees worked on it grow more vigorously than those on sour orange and give better yield of fruit of really good quality from the start. The root system is well provided with strong fibrous roots though it is somewhat shallow compared to that of the sour orange.

The variety used in this experiment is a hybrid type which was selected for its vigour and prolific bearing habit. These hybrid types go under different local names such as *Haldodan*, *Sideran* &c., and are probably produced as a result of cross pollination with other citrus varieties, such as pummelo and sour orange. The fruits are coarse and larger than the common sweet orange. They are sub-acid in flavour.

In the early stages the seedlings have numerous prominent spines and are not unlike sweet orange seedlings in appearance, but their influence on the scion is probably different from that of the true sweet orange.

Pummelo (C. *Maxima* Merr.). The pummelo or *jambola* is a large tree which grows well in home gardens in the wet zone. Several types are known to occur, some having round fruits, others pear shaped. Some are pink fleshed, while others have flesh of ordinary lemon colour. Being a monoembryonic variety the seedlings show considerable variability. They are highly susceptible to attack by scale insects and citrus canker in the nursery stage. The variety is not used as a stock on a commercial scale anywhere in the world.

DESIGN OF THE EXPERIMENTS

The Randomized split plot design has been used in all the experiments, and in each subplot there are three plants. Wishart and Sanders (1936) have shown that with the split plot lay-out all the comparisons cannot be made with the same degree of precision. In the experiment at Peradeniya, a greater degree of precision was required for the scion treatments whose effects might be smaller than for the general comparison of the stocks in which greater differences were anticipated, and accordingly the scion treatments were allotted at random to the subplots and the stock treatments to the plots. There are five blocks in the experiment with four plots in each block for the four stocks, and four subplots in each plot for the four scion varieties. The total number of plants in the experiment is 240, which is exclusive of 80 plants in the border row all round the experimental area.

In the grapefruit trial at Hingurakgoda there are six blocks with four plots in each block and two subplots in each plot. Since a greater degree of precision was required in the comparison of the stock treatments each of the two stocks was allotted at random to the subplots in each plot and the scion treatments were randomized over the plots. There is a total of 144 plants exclusive of the border row plants.

Similarly in the orange stock-scion trial at Hingurakgoda there are six blocks with four plots in each block for the four scion varieties and three subplots in each plot for the three root stocks—rough lemon, sour orange and sweet orange. Owing to incidence of canker in the nursery plants on sweet orange stock could not be got ready in time for planting and the records are not complete for publication in this paper.

In the orange trial at Nalanda there are four blocks with five plots in each block for the five scion variety treatments, and two subplots in each plot for the two stock treatments, the total number of plants in the experiment being 120 in addition to those in the border rows.

Five replications are provided in the mandarin trial at Nalanda. The scion varieties are randomized over the plots, and the stocks are allotted to the subplots in each plot, the total number of plants being 120.

PLANTING MATERIAL

The seeds for the experiment were collected from known parent trees and planted in seed beds. In the grapefruit trial at Peradeniya the seedling stocks were transplanted into the experimental area and budded *in situ* after they were well established. In the other trials budgrafts raised in the nursery were used. In selecting the planting materials all variant types and bench rooted plants were rigidly culled out. Budwood was taken from a selected parent tree of each variety.

RECORDS OF GROWTH

Measurements of height and diameter were recorded yearly. The measurements of diameter of the stock and scion were taken with a pair of Vernier calipers at fixed points 6 cms. below and above the bud union.

GRAPEFRUIT TRIAL AT PERADENIYA

The analysis of variance of stock and scion diameter recorded in June 1940, 3 years after budding, is given in Appendix I. Rough lemon stock is significantly bigger in diameter than each of the other three stocks. Its invigorating effect on the scion as indicated by scion diameter is also statistically significant, the mean values for both stock and scion diameters being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	5·66 ..	5·11
Sour orange	3·18 ..	3·26
Pummelo	2·65 ..	2·18
Hybrid orange	2·59 ..	2·41

The differences in stock diameter between the other stocks are not significant, but plants on sour orange are significantly bigger in scion diameter than those on pummelo and hybrid orange, the differences between the latter being not significant. Scion overgrowth was noticeable on many plants especially of Triumph and Foster variety budded on sour orange and this is reflected in the higher mean value of 3·26 cm. for scion diameter compared to 3·18 cm. for stock diameter. In the other stock-scion combinations the mean value for scion diameter is less than that for stock diameter.

Both Walters and Marsh seedless varieties are significantly bigger in diameter than either Triumph or Foster. Their reciprocal effect on the stock as measured by the stock diameter is also significantly greater than that of Triumph or Foster, the mean values being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Walters	4·72 ..	4·33
Marsh seedless	4·42 ..	4·00
Triumph	2·60 ..	2·55
Foster	2·35 ..	2·10

Walters is not significantly superior to Marsh seedless, nor is Triumph superior to Foster in the effect on stock diameter, but in scion diameter the difference between Triumph and Foster is just significant. The interaction is significant in the analysis of both stock and scion diameters.

GRAPEFRUIT TRIAL AT HINGURAKGODA

The analysis of variance of stocks and scion diameters recorded in May, 1944, is given in Appendix II. Rough lemon is significantly bigger than sour orange in diameter and is also significantly more invigorating in its effect on scion. The mean values are as follows :—

	Stock Diam. in cms.	Scion Diam in cms.
Rough lemon	6·10 ..	5·28
Sour orange	4·56 ..	4·23

The interaction is significant, but not the scion treatments.

ORANGE TRIAL AT NALANDA

The analysis of variance of stock-scion diameter recorded in December 1942, is given in Appendix III.

Rough lemon is again significantly superior to sour orange in stock diameter and in its effect on the diameter of the scion, the mean values being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	8·50 ..	5·90
Sour orange	3·27 ..	2·55

In scion diameter only Mediterranean sweet orange is significantly superior to all the varieties except Navalencia, but in its effect on stock diameter it is significantly superior only to Vavuniya and Valencia late orange, the mean values are as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Mediterranean Sweet orange	6·99 ..	5·29
Navalancia	6·13 ..	4·39
Katugastota Orange	6·09 ..	4·08
Valencia Late	5·58 ..	3·77
Vavuniya Orange	4·64 ..	3·60

There are no significant differences in scion diameter between the other varieties, but in regard to the effect on stock growth both Katugastota orange and Navalencia give significantly higher values than Vavuniya orange. The difference in scion diameter between Vavuniya and Valencia late is not significant.

MANDARIN TRIAL AT NALANDA

The analysis of variance of stock and scion diameters recorded in December 1942, is given in Appendix IV.

Rough lemon is significantly superior to sour orange at the 1 per cent. point in the mean values for stock and scion diameter which are as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	8·28 ..	5·63
Sour orange	5·64 ..	3·98

The interaction is also significant, but not the scion variety treatments.

DISCUSSION

Though grown under different conditions of soil and climate all the citrus varieties have made healthy growth on rough lemon which is shown to be not only vigorous in itself but invigorating in its effect on the scion. No symptoms of chlorosis or die-back were observed on young plants budded on this stock, and nearly all of them have now come into bearing.

Lal Singh and Sham Singh (1942, 1944) report that rough lemon has given the best results as a stock for Blood Red Orange in the citrus root stocks trials in the Punjab. In the earlier trials they found that it induced vigorous vegetative growth in young trees of Malta orange, Santra mandarin and grapefruit budded on it.

Similar observations on the vigour of budgrafts of sweet orange and acid lime on rough lemon stock in the root stock trials at Kodur, S. India, are recorded by Naik (1941). Nandi and Bhattacharya (1943) have found rough lemon to be an invigorating stock for local mandarin in Assam.

The sour orange appears to have a variable effect on the citrus varieties budded on it. There is considerable variability even among the budgrafts of the same variety, some being healthy, others are stunted and chlorotic. Most of the Triumph and Foster grapefruit plants were stunted on it and displayed marked scion overgrowth above the budunion. The initial growth of Marsh seedless and Walters was satisfactory, but subsequently gradual decline set in and many of them died back.

The growth of the imported sweet orange varieties was equally poor on sour orange, and many of them were stunted and chlorotic. The two local varieties, especially vavuniya orange, made good initial growth without developing symptoms of chlorosis and die-back, but their rate of growth showed a tendency to slow down after the second year.

The Nagpur Santra mandarin made steady growth on sour orange stock in the early years, but the growth of the two imported Australian varieties was not satisfactory. It remains to be seen whether the Nagpur Santra mandarin plants will continue to grow well on this stock.

The failure of sour orange as a stock for sweet orange has been reported from Java by Toxopeus (1936) who considers that the cause of the failure may not lie in the stock itself, but in some toxic reaction of the scion upon the stock. He found that the scion variety grew normally for 2 to 3 months but eventually declined and withered within 8 to 12 months. No reason is known for the striking failure of sour orange as a stock for sweet orange in S. Africa.

Lal Singh and Sham Singh (1944) report the failure of Blood Red orange through delayed incompatibility with *Kharna Khatta* which is presumably a variety of sour orange. But they find that the local Malta and Santra mandarin grow well on it. This is contrary to the behaviour of the local mandarin in Assam which, according to Nandi and Bhattacharya (1943), is incompatible with Seville or true sour orange. Both Hume (1930) and Swingle (1909) report that Satsuma mandarin is a failure on sour orange in America.

In recent years there has been a marked decline in vigour of lemon trees budded on sour orange in California, and a condition known as " Quick Decline " resulting in the death of Naval and Valencia orange trees on this stock has also been reported by Fawcett (1945).

The sweet orange hybrid has not made a good stock for grapefruit varieties. Many plants of Triumph and Foster, which appear to be inherently weak scions, were stunted and chlorotic on this stock. The other varieties developed symptoms of delayed incompatibility. It is proposed to carry out trials with the common sweet orange as stock.

On pummelo all the grapefruit varieties except Walters developed symptoms of both chlorosis and mottled leaf in the early stages and were stunted in growth. Walters, which appears to be a vigorous scion variety, grew well at the start, but symptoms of delayed incompatibility began to appear after about two years and most of the plants turned chlorotic and died back. Yellowing of foliage followed by die-back has also been noticed

on Valencia late and Meditterranean sweet orange plants budded on this stock.

It was observed by Lee (1921) in the Philippines that most of the commercial varieties of citrus budded on pummelo were attacked by mottled leaf, but trees upon mandarin orange and calamondin stocks made healthy growth. Lal Singh and Sham Singh (1942) have also reported the appearance of mottled leaf on grapefruit trees budded on pummelo stock. Chlorotic symptoms have also been observed on local mandarin plants budded on pummelo in Assam by Nandi and Bhattacharya (1943).

It is clear from the available evidence that pummelo is least suited for use as a stock for citrus. It makes vigorous and healthy growth when left unbudded, and the failure of the scion is probably due to its inability to obtain its requirements of nutrients through the pummelo stock. Apparently when a vigorous scion is grown on it under favourable conditions the appearance of symptoms of incompatibility is delayed.

Whatever the reason may be for the failure of certain stock-scion combinations, it is evident from these trials that rough lemon is an invigorating stock which is compatible with all varieties of grapefruit, sweet orange and mandarin under study, and that it should be used for this purpose in commercial production until more is known of the performance of sour orange and the common sweet orange as root stocks for citrus under local conditions.

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REFERENCES

Baker, R. E. D., 1938 .. Red Root Diseases of Limes in the British West Indies. *Tropical Agriculturist Vol. XV.*, pp. 105–108.

Blackman, V. A., 1937 .. *Imp. Bur. of Fruit Production. Tech. Comm.* No. 9.

Brown, W. R., 1920; 28.. A Series of Stock Trial in Peshawar, *Agric. Res. Ins. Pusa. Bull.* 93.

Fawcett, H. S., 1945 .. A Starch test for Quieta Decline, *Calif. Citrograph 30.* pp. 120.

Hume, H. H., 1930 .. *The Cultivation of Citrus Fruits. McMillan* New York.

Hodgson *et. al.* 1937 .. Rootstock and Scion influence in Citrus—*Calif. Citrograph 22* pp. 110.

Lal Singh & Sham Singh, 1942 Citrus Rootstock Trials in the Punjab II., *Indian Jour. Agric. Sci. XIV.*, pp. 95–100.

Lee, H. A., 1921 .. The relation of stocks to Mottled leaf of Citrus, *Phillipine Journal of Science*, Vol. 18, pp. 85–93.

Marloth, H. M., 1938 .. The Citrus Root Stock Problem. *Farming in S. Africa* 13. pp. 226–231.

Naik, K. C., 1941 .. Annual Report of the Fruit Research Station, Kodur, S. India.

Nandi, H. K., and Bhattacharya, S. C. Five Indigenous Citrus Rootstock Varieties. *Indian Journal Agric. Sci.* XIII. pp. 489–493.

Richards, A. V., 1938 .. Studies on Stock-Scion interaction in Citrus—1. *Tropical Agriculturist* IXCI. pp. 12–24.

Swingle, W. T., 1909 .. The limitation of the Satsuma Orange to Trifoliate Orange Stock. *Bur. Pl. Ind. US. Dept. Agric. Circ.* 56.

Toxopens, H. J., 1936 .. Stock-Scion Incompatibility in Citrus and its Cause. *J. Pomol.* Vol. 14, pp. 368–364.

Webber, H. J., 1926 .. A comparative Study of the Citrus Industry of South Africa. *Union S. Africa Dept. Agr. Bull 6.*

Wishart, J., and Sanders, H. G., 1936 *Principles and Practice of Field Experimentation.* The Empire Cotton Growing Corporation, London.

APPENDIX I.

Grapefruit Trial—Peradeniya

(i) Analysis of Variance of Stock Diameters

	DF.	SS	Variance	F	1% Point.
Blocks ..	4 ..	80·37 ..	20·09 ..	2·53	
Stock treatments ..	3 ..	1133·01 ..	377·67 ..	47·57 ..	5·95
Error (*a*) ..	12 ..	95·24 ..	7·94		
Scion Treatments	3 ..	806·78 ..	268·93 ..	24·29 ..	4·22
Interaction ..	9 ..	697·91 ..	116·32	10·50 ..	2·15
Error (*b*) ..	48 ..	531·50 ..	11·07 ..		
	79	3344·81			

(ii) Analysis of Variance of Scion Diameters

Blocks ..	4 ..	62·81 ..	15·70 ..	2·50	
Stock Treatments	3 ..	956·66 ..	318·89 ..	50·86 ..	5·95
Error (*a*) ..	12 ..	75·29 ..	6·27		
Scion Treatments ..	3 ..	630·95 ..	210·32 ..	89·88 ..	4·22
Interaction ..	9 ..	541·72 ..	60·19 ..	25·72 ..	2·15
Error (*b*) ..	48 ..	112·17 ..	2·34		
	79	2379·60			

	Rough lemon in cms.	Sour orange in cms.	Pummelo in cms.	Sweet orange hybrid in cms.	Significant differences in cms.
Mean values per subplot for stock effect on diameter of scion ..	15·33 ..	9·77 ..	6·53 ..	7·24 ..	2·42
Mean stock diameter per subplot ..	16·97 ..	9·55 ..	7·96 ..	7·78 ..	2·72

	Walters in cms.	Marsh seedless in cms.	Triumph in cms.	Foster in cms.	Significant difference in cms.
Mean scion diameter per subplot	12·98 ..	12·00 ..	7·65 ..	6·30 ..	1·30
Mean values per subplot for scion effect on stock diameter ..	14·17 ..	13·25 ..	7·80 ..	7·04 ..	2·82

APPENDIX II.

Grapefruit Trial—Hingurakgoda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point.
Blocks ..	5 ..	73·72 ..	14·74		
Scion treatments ..	3 ..	68·01 ..	22·67 ..	2·54 ..	5·42
Error (*a*) ..	15 ..	133·67			
Stock treatments ..	1 ..	212·52 ..	8·91 ..	54·63 ..	8·02
Interaction ..	3 ..	103·56 ..	34·52 ..	8·87 ..	4·87
Error (*b*) ..	21 ..	81·85			
	48 ..	697·33			

Analysis of Variance of Scion Diameters

	DF	SS	Variance	F	1% Point
Blocks	5	40·51	8·10	1·03	
Scion treatments	3	39·91	13·30	1·69	5·42
Error (*b*)	15	118·01	7·87		
Stock treatments	1	117·50	117·50	35·93	8·02
Interaction	3	70·28	23·43	7·17	4·87
Error (*b*)	21	68·65	3·27		
	48	454·86			

	Rough lemon in cms.	Sour orange in cms.	Significant difference in cms.
Mean values per subplot for stock effect on scion diameter	15·83	12·70	1·45
Mean stock diameter per subplot	18·30	13·68	1·61

APPENDIX III.

Orange Trial—Nalanda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point.
Blocks	3	63·07	21·02	3·22	
Scion treatments	4	212·84	53·21	8·15	5·41
Error (*a*)	12	78·35	6·53		
Stock treatment	1	2468·04	2468·04	2468·04	8·68
Interaction	4	263·87	65·97	8·59	4·89
Error (*b*)	15	115·23	7·68		
	39	3201·40			

Analysis of Variance of Scion Diameters

Blocks	3	21·94	7·31		
Scion treatments	4	129·27	32·32	6·36	5·41
Error (*a*)	12	60·96	5·08		
Stock treatments	1	1012·04	1012·04	1012·04	8·68
Interaction	4	150·23	37·56	11·05	4·89
Error (*b*)	15	51·03	3·54		
	39	1425·47			

	Rough lemon in cms.	Sour orange in cms.	Significant difference in cms.
Mean values per subplot for stock effect on scion	17·71	7·65	1·72
Mean stock diameter per subplot	25·51	9·80	2·58

Measurements in cms.

	Medit. Sweet Orn.	Navalencia	Katug. Orn.	Valencia Late Orn.	Vavuniya Sw. Orn.	Signif. Dif.
Mean scion diameter per subplot	15·88	13·18	12·25	11·30	10·80	3·44
Mean values per subplots for scion effect on stock diameter	20·96	18·38	18·26	16·73	13·93	3·90

APPENDIX IV.

Mandarin Trial—Nalanda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point
Blocks	4	45·06	11·27		
Scion treatments	2	60·00	30·00	1. 9	8·65
Error (*a*)	8	123·52	15·44		
Stock treatments	1	471·24	471·24	33. 8	9·33
Interaction	2	217·15	108·58	7.79	6·93
Error (*b*)	12	167·45	13·95		
	29	1084·42			

Analysis of Variance Scion Diameter

	DF	SS	Variance	F	1% Point
Blocks	4	26·41	6·60		
Scion treatments	2	28·22	14·11	1·5	8·65
Error (*a*)	8	74·62	9·33		
Stock treatments	1	183·03	183·03	20·8	9·33
Interaction	2	124·96	62·48	7·1	6·93
Error (*b*)	12	105·12	8·80		
	29	542·86			

	Rough lemon in cms.	Sour orange in cms.
Mean values per subplot for stock effect on scion diameter	16·88	11·95
Mean stock diameter per subplot	24·85	16·92

SUMMARY

All four varieties of grapefruit (C. *paradisi* Macf.) at Peradeniya—Walters, Marsh Seedless, Triumph and Foster—made healthy growth on rough lemon (C. *jambhiri* Lush.), an invigorating stock.

On sour orange (C. *Aurantium* L) and hybrid sweet orange (C. *sinensis* hybr.) their growth was variable with a tendency for most plants to be stunted and chlorotic. Scion overgrowth was noticeable in many on sour orange, a semi-dwafing stock.

All the varieties failed on pummelo (C. *maxima* Merr.). Triumph and Foster were the first to become stunted and chlorotic while Walters the most invigorating scion was the last.

All four varieties—Walters, Cecily Seedless, Marsh Seedless and Triumph—at Hingurakgoda showed similar behaviour as at Peradeniya on rough lemon and sour orange.

The seven varieties of sweet orange—Vavuniya, Bibile, India, Valencia Late, Mediterranean Sweet and Washington Naval, at Nalanda and Hingurakgoda were compatible with rough lemon, but on sour orange the gowth of the imported varieties was variable, many being stunted and chlorotic. The local varieties, especially Vavuniya, made healthy growth although the plants were comparatively small.

All three mandarin varieties (C. *nobilis Var.* deliciosa)—Nagpur Santra, Emperor and Beauty of Glen Retreat at Nalanda were compatible with rough lemon, but on sour orange Nagpur Santra made healthy growth while Beauty of Glen Retreat and to some extent Emperor were failures.

STUDIES IN THE PREPARATION, PROPERTIES AND ASSAY OF COMMERCIAL PAPAIN

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SUMMARY

STUDIES of a fundamental and practical nature on the latex of the papaya fruit have shown that :—

(1) Papaya latex coagulates rapidly on stirring in a flat dish as a result of physico-chemical changes brought about by atmospheric oxidation.
(2) The oxidation of papaya latex is promoted by oxidizing enzymes belonging to the class called peroxidases.
(3) Common salt is quite suitable as a coagulating and protective agent for papaya latex.
(4) Commercial papain of good quality can be prepared from papaya latex by sun-drying or oven-drying for 6 to 8 hours between 50° C and 55° C or by drying to the consistency of a fairly hard paste of composition about 20 per cent. added common salt, 45 per cent. papaya latex solids and 35 per cent. moisture.
(5) Papaya latex should be dried to a moisture content below 10 per cent. unless common salt is used as a protective agent. Samples having a moisture content above 10 per cent. lose their activity very rapidly and undergo a change in colour from pale cream to dark brown within a period of about one year.
(6) A simple modification of the gelatine viscosity method can be used for comparing the proteolytic activities of samples of commercial papain.
(7) Good quality commercial papain (not treated with common salt) should have a pale cream colour, a pungent but not unpleasant odour, a moisture content not exceeding 8 per cent., a minimum nitrogen content of 11·5 per cent. on a moisture free basis, and a proteolytic activity not less than 70 per cent. of a freshly prepared sample.

INTRODUCTION

Commercial papain is prepared by sun-drying, oven-drying or vacuum-drying the latex extracted by lancing the mature green fruit of the papaya tree (*Carica papaya*).

The cultivation of the papaya tree, the method of lancing the fruits and extracting the latex and drying it, have been described in a previous number of this journal (1). This data has been very valuable in many respects. However, as a result of recent advances in our knowledge of the properties of the latex, further investigation appeared desirable in order to improve the local methods of production of commercial papain.

Commercial papain is widely used as a raw material in industry for pharmaceutical preparations, for clearing fruit juices and fermented liquors, for tenderizing meat and for preshrinking and improving the handle of wool (2).

Papaya latex is known to contain at least two proteolytic enzymes called papain and chymopapain (2). These enzymes lose their activity as a reslt of atmospheric oxidation promoted by certain substances present in the latex. The nature of these substances will be discussed at a later stage in this paper.

The inactivation of the proteolytic enzymes in commercial papain can be reversed by means of certain reducing agents like hydrogen sulphide, hydrogen cyanide, sulphides and sulphites. After prolonged exposure to oxidizing influences, however, the material is no longer capable of reactivation (3). Therefore, commercial papain does not keep indefinitely and it is necessary that its proteolytic activity should be determined, in order to ascertain its quality.

METHODS OF ASSAY

The methods of determining the proteolytic activity of commercial papain described in a previous number of this journal (1), have been abandoned by modern workers as they were found to be cumbersome and not accurate enough. The tentative casein digestion method of the A.O.A.C. (4), was tried out and found to involve the use of as much as 200 cc of 95 per cent. ethyl alcohol for every titration. Moreover, the method itself was rather cumbersome, though accurate enough for ordinary purposes. Eventually the modified milk clotting method of Balls and Hoover (5), was used with satisfactory results.

It was brought to the writer's notice that a simple and quick method of determining the proteolytic activities of samples of commercial papain would be useful to the producer. The gelatine viscosity method (6), was therefore modified and a simple apparatus in the form of a capillary-pipette of about 25 cc. capacity devised. The pipette was 45 cm. long and had a capillary tube 15 cm. long of 1 mm. bore, attached to the end. The time of flow of a 5 per cent. aqueous solution of gelatine at room temperature, at about 30°C, from a point marked at the top stem of the pipette to a point marked at the bottom stem should be about sixty seconds. The procedure adopted was as follows :—

A 0·1 per cent. aqueous solution of the commercial papain was prepared by grinding the product to a paste with water and then diluting it. 1 cc. of this solution was then added to 30 cc. of a 5 per cent. aqueous solution of gelatine prepared by warming the gelatine gently with water until it was completely dissolved and cooling it to room temperature. The two solutions were well mixed and allowed to remain at room temperature for 15 minutes. The time taken for the gelatine solution to flow from one point in the capillary-pipette to the other as described above was noted by means of a stop-watch before

and after treatment with the commercial papain solution. The time of flow (t) in seconds is given by the formula :—

$t = K\frac{v}{d}$, where (v) is the viscosity coefficient, (K) a constant for the particular pipette and (d) the density of the gelatine solution. Now, if t_1 and t_2 are the times of flow before and after treatment with the commercial papain solution, repectively, then the proteolytic activity (A) is given by the relationship :— $A = \frac{t_1 - t_2}{t_1}$. The change in density due to the addition of 1 cc. of the commercial papain solution to 30 cc. of the gelatine solution was negligible.

It should be noted that by this method, it is only possible to state whether a particular sample is inferior or superior to another, as there is no simple relationship between activity and enzyme concentration (6).

EXPERIMENTAL

The investigations on the properties of papaya latex and its behaviour when exposed to air indicated that the coagulation of the latex was a physico-chemical change brought about by atmospheric oxidation. This was accompanied by a fall in pH from 6·2 to 5·8 and was probably due to the formation of acidic substances.

The fresh latex had a moisture content of about 80 per cent. It took about 4 to 6 hours to coagulate on standing ; but rapid coagulation occurred in about 10 minutes when it was poured into a flat dish to form a thin layer, and then stirred vigorously.

Papaya latex was observed to keep fresh for about 4 hours without appreciable doterioration in activity. On keeping for longer periods, however, decomposition set in with the development of an offensive odour and accompanied by a rise in pH to 7.2 in about 24 hours. This decomposed product gradually darkened to a brown colour on drying. This darkening was probably due to the oxidation of a chromogenic substance present in the latex, as in the case of apples (7). The darkening of papaya latex was further enhanced by the use of iron utensils. Iron appears to catalyse the above reaction. The presence of oxidizing enzymes belonging to the class called peroxidases in the latex, was demonstrated by the benzidine colour reaction, in the presence of hydrogen peroxide (8). These enzymes are thermostable and promote oxidative changes which reduce the proteolytic activity of papaya latex during drying and storage (5).

It was observed by Balls *et al.* (5), that common salt had a remarkable coagulating effect on the latex. The writer observed that the fresh latex required about 3 per cent. by weight of common salt to coagulate it. Moreover, common salt was reported to have a protective effect on the proteolytic enzymes in the latex, provided the treated latex was not completely dried A paste prepared by partially drying the latex treated with common salt.

to give a final composition of 35 per cent. papaya latex solids, 20 per cent. common salt and 45 per cent. moisture, was found to have undergone no appreciable loss of activity on exposure to air at about 30°C. for 14 days. It did not lose activity to any appreciable extent for as long as 50 days and less than 10 per cent. in 190 days, when kept in airtight vessels. This method was investigated by the writer and it was confirmed that a minimum concentration of 20 per cent. common salt in the final product was necessary to produce a paste of satisfactory consistency. A sample of paste was prepared by adding 10 per cent. of common salt by weight to the latex and drying the mixture in the sun to a stage when the material became thick and plastic. This product was found to contain 20 per cent. common salt, 45 per cent. papaya latex solids and 35 per cent. moisture.

Papaya latex after coagulation can be converted into thin uniform worms by passing it through a colander, string-hopper squeezer or potato-squeezer, having tiny holes. These utensils could be made of aluminium, brass or stainless-steel. If iron is used, it should be heavily tinned. The material was distributed uniformly in thin layers on drying trays covered with muslin cloth. The material was then dried in the sun or in a well ventilated drier between 50°C. and 55°C., for about 6 to 8 hours, to give a pale cream product with a moisture content below 8 per cent. The dried product should be quite crisp and crumble easily to a powder when crushed. Products not treated with common salt and having a moisture content above 10 per cent. were found to deteriorate very rapidly even on storage in airtight bottles. They lost proteolytic activity almost completely with the development of an offensive odour and changed in colour from pale cream to dark brown within an year. It was observed that good quality commercial papain (not treated with common salt) generally had a moisture content of 5 per cent. to 8 per cent. and a nitrogen content of 11·5 per cent. to 11·8 per cent. on a moisture-free basis. It had a pale cream colour and a pungent but not unpleasant odour. Commercial papain in the form of a half dried paste containing 20 per cent. common salt was observed to have a pale cream colour and to retain the pleasant odour of fresh papaya latex for a longer period than the former.

METHODS OF PRODUCTION

The above investigations indicate that commercial papain of good quality can be produced under local conditions by the following methods :—

(1) The latex is extracted by lancing the mature green fruits lightly on the surface by means of a piece of glass with a sharp edge, a stainless steel knife or a bamboo splinter with a sharp edge. This operation is done in the mornings before 10 A.M.

(2) The latex is collected in glass or porcelain vessels. Coconut-shells or the leaf-sheaths of arecanut palms could also be used. The latex is pooled and then poured into flat enamel or earthen-ware vessels and stirred vigorously by means of a wooden spoon till it coagulates.

(3) The coagulated latex is immediately passed through a colander, string-hopper squeezer or a potato-squeezer, made of aluminium, brass or stainless-steel. If iron is used, it should be

heavily tinned. The material is exuded as thin uniform worms and is evenly distributed in thin layers on drying trays covered with muslin cloth.

(4) The material is dried in the sun or in a well ventilated drier at 50°C. to 55°C., till it becomes crisp. The product takes about 6 to 8 hours to dry to a moisture content below 8 per cent.

(5) If producers wish to use common salt as a protective agent, a half dried paste is prepared by adding 10 per cent. by weight of common salt to the latex. The subsequent process is as described in para. 3. The material is dried in the sun or in the drier at 50°C. to 55°C., until it becomes thick and plastic. The product takes about 2 to 3 hours to dry to this consistency.

(6) Commercial papain should be packed immediately after drying in tins free from rust and sealed airtight. It is preferable to evacuate the air from the tins and seal them to ensure good keeping quality. The tins should be kept in a cool place preferably under cold storage.

(7) The product, soon after packing in tins, should be transported with as little delay as possible to the central clearing house.

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REFERENCES

(1) Stockdale, F. A.—The cultivation of papaya and the preparation of papain. The Tropical Agriculturist, 1927, Vol. 68.

(2) Ellis, W. J., and Lennox, F. G.—Some observations on Australian-grown papain. Journal of the Council for Scientific and Industrial Research, 1943, Vol. 16.

(3) Balls, A. K., Thompson, R. R., and Jones, W. W.—Crude papain. Industrial and Engineering Chemistry (Ind. Ed.) 1940, Vol. 32.

(4) Journal of the Association of Official Agricultural Chemists, 1938, Vol. 21, p. 97.

(5) Balls, A. K., Lineweaver, H., and Schwimmer, S.—Drying of papaya latex. Industrial and Engineering Chemistry (Ind. Ed.) 1940, Vol. 32.

(6) Lennox, F. G.—The Gelatine Viscosity Reduction Method of Measuring Proteolytic Activity. Journal of the Council for Scientific and Industrial Research, 1943, Vol. 16.

(7) Balls, A. K., and Hale, W. S.—Peroxidase in the Darkening of Apples. Industrial and Engineering Chemistry 1935, Vol. 27.

(8) Cruess, W. V.—Dehydration of Fruits and Vegetables. Industrial and Engineering Chemistry (Ind. Ed.) 1943, Vol. 35.

RATE OF NUTRIENT SUPPLY IN TWO MAJOR SOIL TYPES OF THE ISLAND

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SUMMARY

ONE of the most important factors conditioning soil fertility is that which takes cognizance of soil nutrients. This study is concerned with those aspects of a soil which may help in ascertaining its inherent fertility commonly associated with its colloids. It is not the quantity factor but the intensity factor, or rate of nutrient supply in soluble form or pseudo-solution, that has been made the special subject of this investigation.

The two soils selected for this purpose are entirely different in character. One sampled at Nalanda is a non-lateritic loam, slightly alkaline, and having a fairly good supply of organic matter and a reserve of alkaline—earth carbonates. The other from Peradeniya, is a lateritic loam, slightly acid in reaction and containing only a fair quantity of organic matter but none of the carbonates.

The conclusions drawn from this study are summarized briefly below :—

1. In the case of exchangeable bases :—
   - (*a*) The nutrient supply to the soil solution or liquid phase of the soil depends not only on the organic status of the soil but also on the rate of nitrification taking place.
   - (*b*) The rate of dissolution of calcium is much higher than that of magnesium.
   - (*c*) The soluble ammonia content of both soils is low.
   - (*d*) Iron and more particularly manganese are brought into solution slowly but the former tends to be dispersed in colloidal form under the conditions of the experiment.

2. In the case of anions :—
   - (*a*) Inorganic phosphate is present only in minute amounts but there is a tendency for this low concentration to be maintained by quick replenishing. Organic phosphate is present in extremely low concentration and its behaviour is similar to that in inorganic form.

(*b*) Nitrates are, in the main, responsible for bringing bases into solution.

(*c*) Chlorides have hardly any power of being produced in soluble form from unionised conditions.

(*d*) The amount of organic matter in solution or pseudo-solution appears to be dependent on the organic status of a soil.

The practical application of the knowledge gained hereby is discussed.

INTRODUCTION

The soil chemist engaged on advisory work on an extensive scale is obliged to take cognizance of a number of factors conditioning soil fertility and of these the most important is that of soil nutrients, the study of which helps him in advising suitable measures for maintaining and even increasing soil fertility. It is only by means of systematic survey and analyses on a large scale, involving the carrying out of innumerable determinations both qualitatively and quantitatively in a well equipped laboratory, that any fairly comprehensive view of the state of fertility of a soil can be attained. In addition to the chemical analytical figures obtained a vast amount of empirical observations on the effects of soil treatment is made by pot and water cultures, and field experiments, but, it is doubtful whether the knowledge thereby established completely solves the problem. It is well established that soils vary in their inherent potentialities for crop production and also that these differences are attributed to the soil colloids—the clay and the humus.

This paper deals with some of those aspects, which throw light on the inherent fertility of two entirely different soils. It is not the quantity factor but the intensity factor or rate of supply of nutrients in soluble form or pseudo-solution that has been made the special subject of this investigation.

Attempts have been made by various workers to devise simple methods whereby the inherent fertility of a soil may be assessed. In certain cases conductivity measurements on soil suspensions were made (*a*) immediately and (*b*) after standing for a period of time. The increase in conductivity, which is brought about mainly by micro-organic activity, has been proposed as measure of soil fertility. Unfortunately such conditions are quite different to normal field conditions and hence the data obtained cannot be properly interpreted. Nevertheless, it has to be emphasized that it is the rate of nutrient supply in a soil or the ionic pressure of its nutrients that is an important factor in estimating fertility. P. Kottgen and L. Jung (1) have shown that " the ionic pressure curves obtained by means of electro-ultra filtration give a better picture of soil fertility than the relative numbers obtained by various extracting substances. " Thus, there appears to be some advantage in the determination of water soluble constituents. Such studies are of special application especially when dealing with soils from semi-arid regions where irrigation is practised and for this reason is of special importance in Ceylon.

EXPERIMENTAL

Soils

The two soils selected for this purpose are entirely different in character. One sampled at Nalanda is a non-lateritic loam, slightly alkaline, and having a fairly good supply of organic matter (3·3 per cent.) and a reserve of alkaline-earth carbonates (1·52 per cent.) The other from Peradeniya, is a lateritic loam, slightly acid in reaction and containing only a fair quantity of organic matter (1·68 per cent.), but none of carbonates.

Methods

The following methods of analyses, which have been found to be highly reliable, were employed. pH electrometrically, conductivity by a special apparatus devised by the author, chloride volumetrically, ammonia by the Pregl micro-chemical Kjeldahl method, nitrate-nitrite (nitrogen) by reduction to ammonia using Kahlbaum reduced iron, organic matter by a modification of the Budapest soil-carbon method, calcium as oxalate by isoelectric precipitation, magnesium by micro-chemical titration employing an achromatic indicator, phosphoric acid by the Denige's colorimetric method adapted by W. M. Holman and A. G. Pollard (2) for the use of permanant glass standards in a Lovibond tintometer, and iron also colorimetrically employing thioglycollic acid.

Procedure

The soluble constituents in each of the two soils were leached out at varying intervals of time ; but as the ratio of soil to water is important with respect to anions other than chloride and nitrate and as the ratio has also a bearing on the relative proportions of the cations owing to exchange phenomena, a fixed relationship between weight of soil and volume of water was maintained throughout the investigation. As it was also essential that the soils should be packed under conditions approaching that in the field the following procedure was adopted. A bakelite impregnated tube, 30 inches long and $2\frac{1}{2}$ inches diameter was charged with one Kilo of air dried soil in small quantities at a time. Each layer was suitably consolidated by even pressure using a ram-rod before the next was added. The tube, the lower end of which after being covered by muslin cloth, was placed on a glass funnel fitted with No. 5 Whatman filter paper. A total volume of 750 ml. of distilled water, in three lots of 250 ml. added at intervals of one hour, was poured into the tube. The percolate obtained was labelled No. I. In like manner the soil was subjected to six further leachings, the interval between leachings being increased as indicated below :—

Percolates (Series)	1	2	3	4	5	6	7
Interval between series (days)	—	4	10	42	55	65	72

The results of analyses are set forth in Tables I to XII A & B are independent replicates of the Nalanda soil and C & D of the Peradeniya soil.

It will be seen that the first percolate is the richest in practically every constituent, especially in chlorides. Of the bases, calcium predominates in the percolates. It is leached six to ten times as rapidly as magnesium—*vide* Tables VII, VIII and IX. Since the ratio of exchangeable Ca/Mg is generally below six in Ceylon soils, continuous leaching will necessarily bring about a

deficiency of calcium sooner than that of magnesium and this will be marked in the case of soils derived from dolomitic limestone—$CaCO_3.MgCO_3$. Moreover, as there is the tendency for basic ions (cations) to be leached in excess of acidic ions (anions) as reflected in the pH values of the percolates (Table I), the pH of the soil will gradually be lowered (Table XII) and at the same time the ratio of exchangeable calcium to total exchangeable bases will diminish. The author has found this to hold good in the case of all soils which he has examined. This was very markedly observed in soils, which are strongly acid, *i.e.*, pH 4–5.

In Table II, the electrical conductivity readings for 10 ml. of the percolates are given. It will be seen that the Nalanda soil (A& B) is richer in ionisable constituents than the Peradeniya soil and that neither of them, even after an interval of 72 days, attains its original ionic pressure.

A glance at Table III shows that chlorides are hardly replenished. The small amounts present in the second and subsequent percolates are possibly due to incomplete leaching under the conditions of the experiment.

That ammonia is present only in very small amounts in soil water is indicated in Table IV. The losses of ammonia from soils under swamp conditions should therefore be negligible. This has been demonstrated by A. W. R. Joachim and S. Kandiah (3). It therefore follows that no advantage is gained by making split applications of ammoniacal fertilizers in manuring swamp paddy. The table (*vide* figures for 2nd. and 3rd. percolates) also brings out clearly that as soon as land is irrigated the ammonia content in soil water is temporarily raised slightly.

Nitrates, produced solely by nitrification, as there is no possibility of any photo-chemical action (4) taking place under the conditions of the experiment, are, in the main, responsible for bringing bases into solution—Table V.

The amount of organic matter (Table VI) in true and or colloidal solution is much higher in the Nalanda than in the Peradeniya series and therefore appears to be dependent on the organic matter status of the soils. The Nalanda soil has an organic matter content of 3·30 per cent. against 1·68 per cent. for the Peradeniya soil.

Table X reveals that inorganic phosphates are present in the solutions in extremely low concentration but in the percolates 4, 5, 6 and 7 the amounts are of the same order as in the first leachate indicating rapid replenishment.

The iron contents of the percolates obtained from the Nalanda soil are lower than those from the Peradeniya soil but this may be partly due to a certain amount of dispersed colloidal matter in the latter case, although there is the possibility that the dissociation of iron is less at high pH values—the Nalanda soil being alkaline—Table XI.

The behaviour of manganese appears to be similar to that of iron. Being present only in minute amounts, figures for this constituent are not set forth in a table.

PRACTICAL APPLICATION

It is being increasingly recognized in India (5) that the next stage in improving yield of crops and in decreasing cost of production lies not so much in evolving fresh varieties as in improving soil fertility through efficient soil management and judicious use of manures. Dr. Harold Mann, who spent many years of his life in India, taking part in a discussion at a meeting of the Royal Society of Arts where Sir Bryce Burt read a paper on Agricultural

Progress in India during the decade 1929–39, said that the soil in India is about the poorest in the world and until a method can be found for improving the soil, the improvement of crops will not go much further than it has gone up to the present. That we are no better off than our neighbour, India, in our heritage, the soil, is forcibly brought out in this investigation which has conclusively proved that the rate of dissolution of plant nutrients is slow even in these soils which are above the average fertility level of those of Ceylon. This is not surprising as the soils of the Island are probably the oldest in the world and have been subjected to high temperatures and fairly heavy rainfall as a result of which they have been leached. The base, calcium, has been shown to be preferentially lost. That the waters of Ceylon are rich in calcium silicate has been proved by oceanographic surveys (privately communicated), yet do we systematically lime the soil, if we lime at all, to make good the loss ? We deceive ourselves if we think that we can cheat the soil. Land is opened up and fair yields are obtained for a few years. Then cultivation becomes unprofitable. The loss of nutrients must therefore be reduced. Are we making use of these two facts (1) that transpiration by the plant and (2) the retention of moisture by the organic matter in the upper layers of the soil reduce leaching ?

Is the average Agriculturist aware that a grass ley is beneficial also because it reduces leaching considerably and holds bases, especially calcium ? The importance of maintaining the calcium status of a soil should be realized because the base holding properties of its clay-colloids diminish fairly rapidly as this constituent is leached away. The converse is also fortunately true for alkaline waters containing lime have been observed to bring about a gradual improvement in the capacity of the soil to hold bases (6). Liming should therefore be regularly carried out. No less important than liming is the maintenance of the organic matter status of a soil. When it is continuously cultivated its organic matter is burnt out and the soil falls to a powder and becomes liable to erosion. This must be avoided. Bulky organic manures like green manures, cattle manure and compost should be applied frequently and the land, which should under no circumstances be left bare fallow, rested for a period of time under grass. It has to be added that if crop yields are to be maintained it is necessary to supply those nutrients removed in the crop. However, as different plants vary greatly in the relative amounts of nutrients they absorb even when grown under similar conditions, the exact manurial requirements of each crop should be determined by carrying out field experiments.

This investigation has shown that a sufficiency of lime and organic matter is necessary to get the best effect from added fertilizers. It also clearly brings out that lime promotes the decomposition of organic matter. We find that where there is a surplus of lime as in soils associated with limestone, *e.g.*, those of Jaffna, Dambulla, Nalanda and Tabbowa, the soils are generally poor in nitrogen and organic matter.

Thus for the maintenance of fertility—

(1) The loss of nutrients by erosion leaching &c., should be reduced to the barest minimum,

(2) The application of lime and bulky organic manures should be systematically carried out and

(3) The nutrients removed in the crop should be made good.

REFERENCES

(1). Kottgen, P. and Jung, L.—Chemical Abstract, May 20, 1944, col. 2431.

(2). Holman, W. M., and Pollard, A. G.—The colorimetric determination of phosphate—Society of Chemical Industry, Vol. LVI., 1937, pp. 339T–343T.

(3). Joachim, A. W. R., and Kandiah, S.—Laboratory and field studies on green manuring under paddy land (anacrobic) conditions—Tropical Agriculturist, Vol. LXXII., 1929, p. 253.

(4). Gopal, Rao G., and Dhar, N. R.—Photo-sensitized oxidation of ammonia and ammonium salts and the problem of nitrification in soils—Soil Science, Vol. XXXI., 1931, pp. 379–384.

(5). Annual review of Biochemical and Allied Research in India, Vol. X., 1939.

(6). Hull, H. H., and Stevens, N. E.—Changes in pH and in base—exchange properties of Cranberry soils following the use of alkaline water—Soil Science, Vol. 58, November, 1944, pp. 405–408.

TABLE I

pH values of the percolates

	1	2	3	4	5	6	7
A	7·01	7·80	7·66	7·33	7·26	7·13	7·10
B	7·00	7·76	7·70	7·30	7·33	7·23	7·26
C	6·43	7·30	7·13	6·73	6·70	6·76	6·53
D	6·38	7·36	7·13	6·66	6·56	6·70	6·50

TABLE II

Conductivity of the percolates

	1	2	3	4	5	6	7
A	6·75	5·0	3·75	3·5	3·25	3·50	3·25
B	6·75	5·5	3·75	3·5	3·25	3·50	3·25
C	3·0	2·75	2·00	1·75	1·50	1·75	1·50
D	3·0	2·75	1·75	1·50	1·25	1·50	1·25

TABLE III

Chloride content in p.p.m.

	1	2	3	4	5	6	7
A	57	5·0	4·5	4·0	3·5	3·6	3·6
B	57	5·0	3·0	3·0	2·5	3·0	2·8
C	17	4·0	3·0	2·5	2·2	2·4	2·2
D	16	3·5	2·5	3·5	2·2	2·0	2·0

TABLE IV

Ammonia content as p.p.m. of N.

	1	2	3	4	5	6	7
A	1·8	4·0	4·8	·30	·48	·24	·36
B	1·8	4·0	3·0	·24	·33	·24	·24
C	·57	·28	·49	·06	·12	·12	·12
D	·42	·14	·35	·09	·15	·18	·12

TABLE V

Nitrate and Nitrate contents as p.p.m. of N

	1	2	3	4	5	6	7
A	23·0	4·5	2·0	9·8	10·3	16·8	10·8
B	23·0	4·9	2·0	8·3	10·9	18·3	12·6
C	8·9	3·0	·35	5·8	5·2	7·6	6·6
D	8·7	1·8	·35	3·9	2·6	5·1	3·8

TABLE VI

Organic matter expressed as p.p.m. of C

	1	2	3	4	5	6	7
A	46	13·2	9·6	10·8	9·6	10·8	10·0
B	49	10·8	10·0	8·1	7·7	9·6	10·8
C	10·8	1·2	·7	1·2	1·2	1·2	1·2
D	9·6	1·2	·7	·9	1·0	1·2	1·0

TABLE VII

Calcium content as p.p.m. of Ca

	1	2	3	4	5	6	7
A	123	82·5	50·5	45·5	33·7	50·6	38·0
B	115	80·8	60·6	38·7	35·4	51·6	38·8
C	20·2	18·5	14·3	11·8	8·0	11·5	8·6
D	19·5	17·7	15·2	10·8	8·0	9·2	6·5

TABLE VIII

Magnesium content as p.p.m. of Mg

	1	2	3	4	5	6	7
A	13·7	11·3	7·96	6·84	4·60	7·89	6·6
B	11·6	10·3	10·0	5·62	4·68	8·04	6·6
C	2·76	2·45	1·84	1·48	·99	1·41	1·08
D	2·55	2·30	1·99	1·33	1·02	1·21	·81

TABLE IX

$\frac{Ca}{Mg}$ ratios in the percolates

	1	2	3	4	5	6	7
A	8·98	7·30	6·34	6·65	7·33	6·41	5·76
B	9·91	7·84	6·06	6·89	7·56	6·42	5·88
C	7·32	7·55	7·77	7·97	8·08	8·16	7·96
D	7·65	7·70	7·64	8·12	7·84	7·61	8·02

TABLE X

Inorganic P2 O5 as p.p.m. of P2 O5

	1	2	3	4	5	6	7
A	·25	·02	·05	·20	·14	·22	·25
B	·21	·02	·06	·18	·21	·23	·24
C	·16	Nil	·02	·20	·14	·20	·15
D	·13	Nil	·02	·21	·23	·18	·18

Values of total phosphoric acid for A and B were only slightly higher and for C and D practically identical with those for inorganic phosphoric acid.

TABLE XI

Iron as p.p.m. of Fe

	1	2	3	4	5	6	7
A	1·1	·5	·2	·3	·3	·2	·3
B	1·0	·5	·2	·2	·3	·3	·2
C	1·5	1·1	1·0	1·2	1·3	1·6	2·2
D	1·4	1·0	1·1	1·3	1·5	1·9	2·3

TABLE XII

pH values of the soils

	Original.	Final (after 7 percolations)
A	8·01	7·76
B	8·01	7·86
C	6·90	6·72
D	6·90	6·79

THE NATURAL REGENERATION OF CEYLON FORESTS

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NEITHER the substantive nor qualifying adjective of the term "Natural Regeneration" carries its full literal significance. It is "regeneration" only in a rather special way and "natural" in a restricted sense. Regeneration implying the reproduction of its own kind as applied to Natural Forests is the last thing we as Foresters desire.

The question of Forest Regeneration arises from one or more of three circumstances :

(*a*) The forest concerned does not carry any of the timber species required, or

(*b*) A sufficient concentration of such species, or

(*c*) Economically desirable species as may have existed have been felled.

In Ceylon these reasons are nearly always simultaneously operative. The second condition is specially characteristic and to perpetuate this under any form of regeneration will be no kind of improvement. The pure ecologists will think of regeneration in terms of seral succession and be inclined to view it as a form of short secondary succession back to original or similar type of forest brought about by biologic interference. Actually we want something more and something better than the regeneration of the original type particularly as regards its specific composition.

This cannot be achieved without active and purposeful manipulation over a period of years. Hence the regeneration we intend is not entirely natural and is not much more than that the seed from which it arises occurs naturally ! This process is, therefore, more accurately an artificial conversion of natural forest into more economically valuable and desirable timber bearing forests suitable to and conditioned by the climatic and edaphic factors of the area concerned brought about by the selective reproduction of the constituent vegetation by natural means. Of the various means of reproduction from which natural regeneration may arise that from seeds is the most important. It is rather a whole complex of factors the nett result of the actions and reactions of which ultimately determine the effective contribution it makes. Amongst the unit factors in its make up must be considered :— the time, periodicity or abundance of the seed fall of a species ; the germination capacity of the seed, its agents of dispersal, its predators ; and lastly, the growth, vigour, pests, diseases and silvicultural requirements of the resultant seedlings.

From the stand point of Natural Regeneration, it is most appropriate, therefore, that organized Silvicultural Research in Ceylon should have

commenced with the study of the Flowering and Fruiting of our principal timber species. This work falls into two phases :—

(*a*) The study of Flowering and Fruiting " en masse " over large areas by the collection and collation of observations carried out on a large number of trees of selected species by numerous widely distributed observers over a period of years, and

(*b*) Observations on individual, numbered and properly identified, trees by single observers in different localities.

The first part of this investigation has been concluded and results published on 31 important species. The work on the second stage of the investigation has been going on for the past three years and monthly observations are being maintained in a large number of phenological observation plots. These give a fair representation of the principle species comprising our major high forest types with a proportionately larger number of plots for the more extensive forest types concerned.

The seedling is the most critical period in the life of the tree. With the usual extravagance of tropical nature, many millions of seedlings come up every year only a small number of which survive ultimately under even the most favourable conditions. Up to a few years ago preoccupation of those engaged on forest work has been almost entirely with the adult exploitable trees. It is indeed a far cry from the seedling of a few days or months to the adult sawable tree of near a century. It is not surprising, therefore, that few of even the preferred timber species were generally identifiable as seedlings. The juvenile forms of certain of our trees—*e.g.*, *Tolol* (Trichadenia zeylanica), *Welang* (Pterospermum canescens), *Bedi-del* (Artocarpus nobilis), *Palu* (Manilkara hexandra) &c., are so very different from what they look like as big trees. Seedlings of others like *Lunumidella* (Melia composita), *Satin* (Choloroxylon swietenia), *Suriyamara* (Albizzia odoratissima) resemble certain common herbaceous weeds. With the inauguration of the Silvicultural Research Branch of the Forest Department, experimental nurseries and gardens were opened up, representative of the principal climatic and forest zones of the Island, where seed germination characteristics and the growth, behaviour, silvicultural requirements, pests and diseases of the seedlings of our principal timber and other forest trees could be more closely and effectively studied than under the vicissitudes of forest conditions. Information on a large number of important species is steadily accumulating from fundamental routine investigations conducted at these places that would in due course assist and make possible the efficient and scientific handling of regeneration of such species under field conditions.

In coppice regeneration two principle types have to be recognized :—

(*a*) True coppice from the stools of large exploitable trees felled.

(*b*) Shoots from young saplings and seedlings that have been cut down.

Both contribute to natural regeneration in different measure and specially in the case of the former varies according to the particular species concerned. The following species are known to coppice exceedingly well :—

Pepaliya, (Aporosa latifolia). *Welipenna* (Anisophyllea cinnamomoides), *Mora* (Nephelium longana and Gardneri), *Dikwenna* (Pityranthe verrucosa), *Madan* (Syzygium cumini), *Guru-kina* (Calophyllum

CALABA), *Kuma* (GLENIEA ZEYLANICA and LEPISANTHES TETRAPHYLLA) others like *Suriyamara*, *Kabalmara* (ALBIZZIA LEBBEK), *Bulu* (TERMINALIA BELERICA), *Gammalu* (PTEROCARPUS MARSUPIUM), *Milla* (VITEX PINNATA) coppice fairly well whilst others still, *e.g.*, Satin, *Palu*, *Hedawaka* (CHAETOCARPUS SPP.) *Hora* (DIPTEROCARPUS ZEYLANICUS), *Bu-hora* (DIPTEROCARPUS HISPIDUS) &c., coppice indifferently or not at all.

There is actually more regeneration as fresh shoots from cut saplings and seedlings than from stool shoots or true coppice—particularly if cut under favourable weather conditions. Most tree species exhibit this faculty which becomes specially useful for the stimulation of advance regeneration that, having been under suppression beyond the limits of elasticity so to speak, has become irresponsive to mere opening up of the overwood.

Excepting in the artificial Fuel Plantations, Up-country, coppice regeneration as such has been attempted only in certain sub-coastal Wet Evergreen High Forests of the Galle District, viz., Urugaha, Yakkatuwa and Polhunnawa Forest Reserves. Observation plots at Yakkatuwa have, however, proved that much the greater part of the regeneration resulting from the so-called " coppicing " has been of seedling origin and not so much from coppice shoots. The following table gives the results of an assessment of Seedling and Coppice regeneration at the end of 3 years from the completion of coppicing operations. In one half of a 20–acre block given to these operations all larger stools of felled trees were dressed and in the other left untreated. Counts were taken from miliacre quadrats taken at $\frac{1}{2}$ chain intervals on either side of two central indicator lines laid down through each acre. The principal species comprising this regeneration were :—

CALOPHYLLUM SOULATTRI, C. PULCHERRIMUM, APOROSA LATIFOLIA, XYLOPIA PARVIFOLIA, CHAETOCARPUS CASTANOCARPUS, C. CORIACEUS and DILLENIA RETUSA.

Class of Regeneration.	Analysis of Regeneration per Acre.										Percentage of coppice to total Regeneration.
	Coppice Origin.					Seedling Origin.					
	<3′	3′–<6′	6′–<12′	12′ & above	Mn Ht.	R	U	E	S	Mn Ht.	
Plot A.											
(i.) Preferred + other timber species ..	460	250	640	140	7·7′	2500	1750	2640	680	8·7′	16·5
(ii.) + Other tree and Small tree spp. ..	640	1140	1070	140	7·7′	5180	4680	4570	820	8·4′	16·4
Plot B.											
(i.) Preferred + other timber species ..	360	230	180	—	6·0′	1540	1770	1270	730	7·5′	12·7
(ii.) + Other tree and Small tree spp. ..	820	450	680	—	6·0′	5680	3910	2040	1140	7·7′	15·4

R = Recruitment. *i.e.*, seedlings of the year of observation.
U = Unestablished seedlings below establishment height of 6′.
E = Established plants 6′ and over in height.
S = Saplings. 12 to less than 25′ in height.

Coppice regeneration will be observed to contribute less than a sixth of the total regeneration. For this reason as well as from examination of dressed and untreated coppice stools there does not appear to be any special advantage to be gained by insisting on the dressing of stumps as in past practice.

Next to coppice, root-suckering is the most important other form of vegetative reproduction. In certain species it is so dependable that it may be employed to the total exclusion of seedlings. Close young stands of *Katu-imbul* (GOSSAMPINUS MALABARICA) *Kohomba* (AZADIRACHTA INDICA), and CASUARINA EQUISETIFOLIA for example may be raised by the simple expedient of soil wounding or surface trenching at intervals. The profuse regeneration of *Satin* and sometimes *Suriyamara* to be seen in newly cultivated '*chenas*' has been found to arise principally from root-suckers. Root-suckers of *Welang* have been observed to spring up in profusion along shallow intercepted trenches delimiting experimental plots in the Northern Division. Other species that have been observed to propagate themselves freely from root-suckers are :—*Diospyros melanoxylon, Dikwenna, Wa* (CASSIA SIAMEA and TIMORENSIS), *Kabal Mara, Ehela* (CASSIA FISTULA), and *Dunu-madala* (STEREOSPERMUM CHELENIOIDES).

Other forms of propagation, *e.g.*, through layering of lower branches and sprouting from detached vegetative parts are of limited occurence. Of indigenous tree species the only case of natural layering observed has been of *Then-Thukki* (DIMORPHOCALYX GLABELLUS). I once came across a branch of this tree remaining perfectly green and vigorously alive though it had been cut and completely severed from the stem more than a year previously. On examination it was found that the twigs which had been just touching the ground had rooted and the translocation streams were apparently of the opposite directions to normal! In the case of certain woody shrubs and herbaceous weeds prolific natural regeneration by layering and detached vegetative parts, *e.g.*, *Kekiriwara* (SCHUMACHERIA CASTANAEFOLIA) *Schigostima hirsuta* and *Lanka palu* (MIKANIA SCANDENS) to mention a few—give no end of trouble to the Silviculturist.

Seeds being the principle means of propagation the presence of parent seed trees is of course the essential requirement for natural regeneration. This does not, however, always and for all species mean that parent seed trees must of necessity be in or even near the site to be regenerated. The necessary minimum proximity of parent seed trees is dependant solely on the dispersal potential of the seeds of species desired. Species with small seed carried by wind or aerial animal agency such as by birds, bats or flying foxes may effectively seed areas miles away from the parent seed trees. *Satin, Ranai* (ALSEODAPHNE SEMECARPIFOLIA), *Mora, Kolon* (ADINA CORDIFOLIA), *Etamba* (MANGIFERA ZEYLANICA), *Milla, Del* and the *Dambu* (SYZYGIUM SPP.) belong to this class of high seed dispersal potential and do not require to be actually on the site. On the other hand large seeded species like *Hal*, (VATERIA COPALLIFERA) species with dehiscent fruits like the *Hedawakas* (CHAETOCARPUS SPP.) or with helicopter mechanisms for their dispersal like *Hora*, the *Duns* (DOONAS or SHOREAS)—or those species the seeds of which are spread by the ground fauna of the forests—*e.g.*, *Palu, Ehela, Mi, Etahirilla* (TURPINIA MALABARICA) the *Kinas* (CALOPHYLLUM SPP.) are not carried far and require to be on the spot. Fortunately for us the dispersal potential of a large number of our preferred timber species is such that it is possible other factors being favourable, to obtain a good proportion of them in natural regeneration particularly in the Wet Evergreen High Forest Type without much concern over the presence or absence of parent seed trees—over small operational areas. Whilst flowering and fruiting has been found to be annual

functions in the case of most of our Timber trees species it has been known that bumper seed-years occur periodically. It is when such seed years coincide with regeneration operations that the best results with particular species, *e.g.*, *Hora* are obtained. Animal depredators of seed may yet upset anticipations. A bumper seed year of *Hora* may be whittled down to poor resultant regeneration by swarms of parakeets and green woodpeckers that feed on the fruits.

Quality, germinative capacity and retention of viability of seeds are other factors that determine the contribution they make. Seed of *Palu*, *Kekuna* (CANARIUM ZEYLANICUM), *Hedawaka*, *Kohomba*, *Ranai* and *Satin*, do not retain viability of seed for long and unless favourable weather conditions follow seed fall the regeneration of such species in that year are poor. The general lack of *Palu* regeneration in the Dry Mixed Evergreen High Forests may in part be due to unseasonal ' seed '—fall.

Weather conditions generally are important particularly before setting of seed and after seed-fall—fair weather without excessive drought for the former period and good sustained rain seen after seed-fall. Naturally rainfall tends to be limiting more in the Dry Zone and hardly at all in the rest of the Island. In this Zone as well as in the Hills, for other reasons, seedlings of certain tree species exhibit a peculiar annual die-back of their leafy shoots year after year whilst the roots continue to develop underground till they are able to sustain the last shoot permanently. This means that such seedlings, *e.g.*, of *Satin*, *Milla* and *Chaddavakku* (WALSURA PISCIDIA) or *Kina* (CALOPHYLLUM WALKERI) and *Dambu* (SYZYGIUM SPP.) of Dry Mixed Evergreen and Sub-Tropical Montane Forests respectively remain in the recruitment stage for 3 to 4 years or more.

Root competition from the trees of the parent overwood is probably the principle single factor we are concerned with. This more than light is what affects the incidence and establishment of natural regeneration under different regeneration operations though they appear to have more to do with the variation and control of light. This competition is more for soil moisture less for soil nutrients and, as is to be expected, is more important in Dry Zone forests. The following results taken from independent sets of experiments carried out in the Puvarasankulam and Nuwaragala Forest Reserves serve to illustrate these points :—

Treatment.	Nuwaragala Reserve Average 16-sub-plots—200 basket plants per treatment per species Age 1½ years.				Puvarasankulam Reserve Average of 8-sub-plots—200 basket plants per treatment per species Age 1½ years.			
	Azadirachta indica.		Berrya cordifolia.		Azadirachta indica.		Berrya cordifolia.	
	Percentage Survival.	Mean Ht.	Percentage Survival.	Mean Ht.	Percentage Survival.	Mean Ht.	Percentage Survival.	Mean Ht.
A. Unburnt and trenched 3′ deep	61	1′ 11″	84	6′ 2″	71	2′ 8″	82	9′ 6″
B. Burnt but not trenched ..	73	1′ 10″	80	4′ 8″	74	1′ 11″	47	5′ 11″
C. Burnt & trenched	80	2′ 3″	73	9′ 10″	83	1′ 9″	68	11′ 9″
D. Controls (untreated) ..	31	11″	73	1′ 6″	34	11″	77	3′ 6″

The use of AZADIRACHTA INDICA, one of the more readily dependable species for planting in these localities as an indicator species was spoilt due to stripping of the leaves and breaking of the plants by monkeys. The results, however, demonstrate quite clearly that the most limiting of the factors influencing the growth of young seedlings in the Mixed Evergreen High Forests is undoubtedly the intense competition for the limited soil moisture offered by the established root systems of the parent overwood. It is interesting and important to note also that a controlled surface burn of the slash obtained from clearing the undergrowth assists the vigour and growth of young seedlings in this type of forest. Such slash burning is unnecessary in Wet Evergreen High Forest type and contra-indicated for the reason that when such burning is feasible it is likely to cause damage by bringing about the death of the characterically thin barked trees of these forests. These results have been confirmed by more recent experiments at the centres mentioned.

Associated with and inseparable from the factor of root competition from the trees of the overwood is the matter of light incidence. Other factors being favourable light is hardly ever limiting in any of our forests at least for seed germination and the early life of seedlings. Indeed shade is necessary and even essential for germination of the seed of forest tree species and the well—being of young forest tree seedlings. For practical purposes no playing about with photoelectric meters is really necessary. Use of such instruments can only measure direct overhead light satisfactorily whereas it is the oblique light that is more important where light as a factor happens to count at all. The canopy manipulation affects the underground conditions more than those above ground and that the former effect is more important from the point of view of natural regeneration must be borne in mind. For these reasons the expression of canopy density as a fraction of the sky-space shut out serves amply for working purposes and as it admits of fairly accurate interpretation in the field has been used in the investigations on which this paper is based.

Soil conditions of the site are not important to the same extent as in the artificial regeneration. Natural regeneration can be only a conversion of a forest to a greater concentration of a selected number of species which are already on the site and these amenable to the conditions therein and are to that extent not of the operator's choice. In the case of small seeded species like *Kolon*, *Rukkatana* (ALSTONIA SCHOLARIS), *Bakmi* (NAUCLEA ORIENTALIS), *Helamba* (MITRAGYNA PARVIFOLIA and TUBULOSA), a fairly clean floor not closely covered with litter is necessary for successful germination.

Making conditions favourable to the development of the desired Timber Tree species necessarily invites also other undesirable species which are generally more prolific and much faster growing. Unless early and relatively frequent attention is given to cleanings profuse regeneration that might initially have reminded one of overstocked nursery—beds may disappear completely within a couple of years. The normal shrub associates of such regeneration are easily controlled and do not give much trouble. Most are useful and must even be specially retained to protect the soil and nurse the desired species. Others, however, are veritable scourges—*e.g.*, *Lanka-palu* (MIKANIA SCANDENS), SCHIZOSTIGMA HIRSUTA, *Wal-kolon* (EUPATORIUM

CONYZOIDES), *Bata* (OCHLANDRA STRIDULA) and *Nellu* (STROBILANTHES SPP.). When natural regeneration poperations in the Wet Zone were first contemplated it seemed hopeless to except success with the ubiquitous fast growing *bata* that characterised most forests of this zone. Experimental investigations conducted in the last few years have been highly successful. We no longer have any misgiving about being able to tackle this particular trouble successfully.

The incidence of certain weed species help to give a rough indication of the extent of the opening up of the overwood in natural regeneration operations. In the Wet Evergreen High Forest type close growths of carpet grasses are indicative of very excessive opening up. Dense masses of *Geduma* (TREMA ORIENTALIS) indicate less drastic but still too excessive opening up. *Kande* (MARCARANGA PELTATA) means the gaps are just too big for general purposes. Excessive felling resulting in the first two conditions are serious blunders or silvicultural crimes and are generally irretrievable. The *Kande* is more beneficient and quite successful regeneration, *e.g.*, of *Hora* has been raised beneath the cover given by it.

Of the animal factors, natural forest regeneration has to contend with; man is the worst culprit. Even in the young sapling stage it is the more important and valuable species that attracts the attention of the illicit feller and just those that disappear—victims of his *katy*. Browsing by sambhur and deer affect the regeneration of certain species and may be impossible, where the wild animal pressure is great, *e.g.*, *Pelan* (KURRIMIA ZEYLANICA), *Del, Jak* (ARTOCARPUS INTEGRA) and *Satin*.

(To be continued.)

DEPARTMENTAL AND OTHER NOTES

CHEMICAL NOTES (19)

FURTHER ANALYSES OF LOCAL MANURES, COMPOSTING MATERIALS, FEEDING STUFFS AND FODDERS

Since the publication in *The Tropical Agriculturist* of May, 1940, of Chemical Note 17, which dealt with the analyses of local manures, green manures, fodders and feedingstuffs, and composting materials (1), several samples of these classes of agricultural products and waste materials have been examined in the Chemical Laboratory, Peradeniya, for advisory purposes. In this Note the analyses of the more characteristic of these samples are recorded and discussed as they are of general interest and utility. Most of the analyses were carried out by Messrs. S. Kandiah and D. G. Panditteseker a, and a few by Dr. D. E. V. Koch, Assistant Chemist. The samples discussed in this paper number 40 and include : 15 manures or waste products which may be used as such, 9 green manures, composts and composting materials, 12 feedingstuffs, and 4 pasture grasses and fodders. The results are shown in *Tables I to IV*.

MANURES

The data of *Table I* relate to manures.

Elephant Dung.—The nitrogen and phosphoric acid contents of the fresh sample are low compared with those of cattle manure, but the well-decomposed sample compares favourably with the latter in these respects. The old sample has a high ash content (due to admixture with earth and foreign material), but its potash and lime contents are remarkably high. If this sample is typical of others, well-decomposed elephant dung should be a very valuable bulky organic manure.

Hare Dung.—The manurial constituents of this material are low considering its low moisture content.

Bat Guano.—Previous analyses (1) of bat guano from other sources in Ceylon have shown nitrogen contents varying from 6·1 to 12·8 per cent, phosphoric acid from 1·1 to 4·1 per cent, and potash from 1·0 to 2·4 per cent. This sample is, therefore, of average quality as regards manurial value. It is reported that the quantity of bat guano available in the Nitre Cave district of Ceylon is not large, but this is a matter for further investigation. The caves, are, however, not easily accessible and transport costs of the manure will be high. But considering the high cost of manures at present, it would be well worth exploiting this useful material wherever it is obtainable.

Fish Sweepings and Fish Scales.—The former is a waste product of the dry fish trade which finds a ready sale. Its manurial value is slightly lower than that of fish manure. A waste material which is, however, not utilized to the extent it might be in Ceylon is fish scales. The sample examined contained over 6 per cent. of nitrogen, 4.5 per cent. of phosphoric acid and 22 per cent. of lime. It is thus superior to fish manure in manurial value and its use,

after grinding is, therefore, strongly advocated, particularly on acid soils because of its high lime content.

Maldive Fish Dust.—The sample examined contained in addition to the dust, pieces of the dried fish in varying sizes up to 1 by $\frac{1}{4}$ inch. In manurial value it is superior to fish manure. As its fat content is low (2·93 per cent.), it would be a useful material for application to local crops provided it is ground down before use.

Margosa and Mee Poonac.—Margosa poonac has a nitrogen content of over 5 per cent. Its fat content is, however, fairly high (9·0 per cent.), and it would, therefore, decompose in the soil relatively slowly. Where available, it could advantageously be used for manuring highland crops. *Mee* poonac is only of low manurial value. Mahua or mowrah cake obtained from the seed of the related species *Bassia latifolia* nitrifies very slowly owing to its high saponin content. As *mee* poonac contains saponins, it is likely to behave similarly.

Tea Sweepings.—The sample examined contained just under 3 per cent. of nitrogen, and about 1·8 per cent. potash. It should be useful for composting with other waste materials or for application to highland crops.

Barnacles and Ship's Bottom Scrapings.—These samples were sent by the Harbour Engineer, Colombo. Barnacles, as would be expected from their nature, consist mainly of calcium carbonate (84 per cent.). Ground down fine, they would be a useful ameliorant for acid soils. The sample contains about 0·5 per cent. of nitrogen. On receipt, the sample of ship's bottom scrapings was in a high state of decomposition. Air-dried, it was a dark grey material with nitrogen and phosphoric acid contents of about 1·5 per cent. and 1 per cent. respectively. This material is best utilized for composting with vegetable wastes.

Potash Manures.—The crude sample is a dark grey and the concentrated product a white granular powder. It was reported to be prepared from local materials, presumably potash husks. The former has a potash content of about 24 per cent. and the latter about 38 per cent. They should make useful fertilizers for most crops, but as they are mainly in the form of chlorides, they would be unsuitable for use on tobacco.

Citronella Ash.—An analysis of a sample made in 1928 (2) showed the following figures: potash 7 per cent., lime 3·3 per cent., and phosphoric acid 1·4 per cent. The present sample is appreciably richer in potash. Citronella ash has been found beneficial for paddy on sandy soils and alkaline clay loams.

GREEN MANURES, COMPOSTS AND COMPOSTING MATERIALS

The analyses of these materials are shown in *Table II.* The tender stem and leaf material of the two leguminous green manures *Mimosa bracaatinga* and *Albizzia sumatrana* is rich in nitrogen, but that of the latter is the richer of the two. The phosphoric acid content of *Albizzia sumatrana* is also higher than that of the former.

Salvinia auriculata, which has recently become a troublesome weed in our water courses is, like its more dangerous ally the water hyacinth (*Eichornia crassipes*), richest in potash of the common plant nutrients, but *Salvinia* has only just over half the potash content of the water hyacinth.

Samples of water hyacinth in Bengal showed much higher potash contents. *Salvinia* is slightly superior to water hyacinth in nitrogen content, but both are poor in this constituent. The former has much more lime and appreciably more phosphoric acid than water hyacinth. *Salvinia* is best used for composting with other waste materials preferably in a partially-dried condition. A sample of compost prepared with it alone as waste material, together with cattle manure, wood ashes and shell lime showed only 9 per cent. of organic matter and 0·27 per cent. of nitrogen.

An example of a sample of good quality compost is that prepared at Walpita Farm from empty maize cobs and coverings, gliricidia loppings, cattle bedding, wood ash and other farm waste. Its organic matter and nitrogen contents are high, and potash and phosphoric acid percentages good compared with those of an average sample of compost.

A material very suitable for composting is citronella spent grass. Compared with that of a sample of the undistilled, dry grass, a sample of the former showed a higher nitrogen content and relatively more phosphoric acid. Considering that citronella ash is relatively rich in potash, the compost prepared from this material can be expected to be well supplied with this constituent.

A raw material which is uncommon in this Island, but which is occasionally to be found in upcountry districts is *papyrus*. The sample examined had nitrogen and ash contents, on a dry matter basis, similar to those of citronella grass. Papyrus could, therefore, be advantageously used for composting.

FEEDINGSTUFFS

Table III furnishes the analyses of the characteristic feedingstuffs examined.

Gingelly Poonac.—A locally grown sample of the poonac prepared in a hydraulic press was compared with one prepared in an expeller press. The analytical data show higher figures for fat, fibre and ash in the former. The lime content of gingelly poonac is high and this is one reason for its high nutrient value.

Dhal "Dust" and "Chuni".—These are by-products in the preparation of cured "dhals" from pulses. The former is a locally-prepared sample and the latter one imported from India. They mainly consist of the husks with part of the adhering kernel of the pulse. The samples are of similar nutritive value, but the "chuni" from India is somewhat richer in protein and has a lower fibre content. They are both very useful feedingstuffs.

Kurakkan Straw and Chaff.—The chaff was obtained as a waste product in the threshing of kurakkan earheads in a tea roller and sifter. It has a similar composition to that of kurakkan straw, but has a lower fibre content than the latter. The straw is richer than rice straw in proteins, but is otherwise of much the same composition as the latter. Its calcium content is slightly lower than that of rice straw.

Tamarind Seed.—This was a sample of the roasted and shelled seed from India. It had a low fibre and high protein and fat contents. In analytical composition it is superior to the cereals as a feedingstuff. Experience is, however, lacking locally in regard to the use of this material

as a feed for farm animals, though it is reported to be utilized for this purpose in India.

Maize "Cake".—This material was received from the Controller of Animal Foods as "maize cake" and consisted of the skins or hulls of the maize kernel. The sample has fair protein and fat contents. While its fibre content is high, compared with other coarse feeding stuffs, *e.g.*, straws, it is much lower in this constituent. It could be used for feeding purposes as a coarse fodder.

Fish Meal and Netheli.—A sample of sprats (*netheli* fish) from the local market showed a very high protein and high lime and phosphoric acid contents. Sprats are a very useful poultry feed. The two samples of fish meal examined were prepared at the Ambepussa Farm from local fish, a variety of *sudayo*, S. One was prepared by removing the skin, bones, head &c. of the fish, drying in the sun and grinding in a mill. The other was dried whole and ground. Both samples are of high nutritive value, but the one with bones &c. is, as would be expected, richer in lime and phosphoric acid than the other. Both samples, however, suffered from the disadvantage that they contained very high percentages of salt. They were, therefore, unsuitable for use as feedingstuffs unless the salt contents were reduced to within the maximum of 4 per cent. permissible. Investigation in this laboratory showed that by soaking the meal in water for about half an hour and decanting or pressing off the excess water, the salt content could be reduced to within the safe limits. In the case of the whole fish, the material had to be steeped in water overnight and then washed and dried.

PASTURE GRASSES AND FODDERS

In *Table IV* the analyses of 4 samples of pasture grasses and fodders are presented. Two of these were carpet grasses (*Axonopus* spp.) from Peradeniya, the broad leaf variety (*A. compressus*) being more widely prevalent than the narrow leaf (*A. affinis*). One was a sample of Wimmera rye grass (*Lolium subulatam*, an imported Australian annual) at the flowering stage from Bopatalawa Farm. The soil on this farm is an acid peaty loam and burnt lime at the rate of 1—2 tons/ acre is generally applied prior to the establishment of pasture. This sample was from a limed area. The last was a sample of maize fodder from an upcountry district.

It will be seen that of these samples, Wimmera rye grass contains appreciably less protein than the other two. It has also more fibre than the broad leaf carpet grass. In regard to mineral composition, the rye grass is richer in phosphorus than the carpet grass species, especially the narrow leaf one. Its calcium content is higher than that of the broad leaf species of carpet grass and slightly less than that of the narrow leaf species.

Compared with British pasture grasses (3), these samples are poorer in lime, phosphorus and protein than one of good cultivated British pasture. They are similar in composition to poor natural pasture in Britain except in regard to calcium in which constituent two of our species are of similar quality to good natural pasture. The analyses show, however, that these grasses are superior in composition to South African natural pasture grasses (4). Compared with Australian data for Wimmera rye grass, the Bopatalawa sample is lower in protein and lime and slightly higher in phosphates than most Australian samples of the same stage of maturity (5).

REFERENCES

1. Chemical Notes 17.—The Analyses of Some Manures, Fodders and Feedingstuffs. Joachim, A.W.R., and Kandiah, S. *Tropical Agriculturist*, Vol. XCIV., May, 1940.

2. Chemical Notes 3. Analysis of Citronella Grass Ash, A.W.R.J. *Tropical Agriculturist*, Vol. LXXI., November, 1928.

3. The Nutritive Value of Pastures from the Point of View of the Mineral Content. Orr, J.B. Grassland Problems. Ministry of Agriculture and Fisheries. Misc. Publn. No. 60.

4. Studies in Pasture Management. Report on the Seasonal Composition of Certain South African Pasture Grasses. Taylor, A.J. Dept. of Agric., S. Africa, Sc. Bull., No. 109.

5. Factors Affecting the Mineral Content of Pastures. Richardson, A.E.V. *et al.* Comm. Austr. Council Sc. Indus. Res. Bull., No. 49.

Chemical Division,
Peradeniya.

A. W. R. J.

TABLE I

Analyses of Manures

No.	Sample	Nature and Origin	Moisture	Organic Matter	Ash	Nitrogen	Phosphoric Acid	Potash	Lime
			%	%	%	%	%	%	%
1	Elephant dung	Fresh, Katugastota	78·6	20·2	1·2	0·27	0·08	0·32	0·16
2	Elephant dung	Decomposed, Katugastota	68·5	15·2	16·3	0·48	0·34	1·64	2·13
3	Hare dung	Dry, Puttalam	11·7	74·7	13·6	0·85	0·38	0·53	0·26
4	Bat guano	Nitre Cave	15·2	67·7	17·1	7·11	2·55	2·18	2·01
5	Fish sweepings	Colombo	—	—	50.3	3.22	3.00	—	4.83
6	Fish scales	Jaffna	14·5	39·7	45·8	6·26	4·52	0·47	22·72
7	Maldive fish dust	With pieces, Colombo	21·2	55·4	23·4	6·84	4·18	—	—
8	Mee poonac	Kurunegala	10·3	—	—	1·58	0·51	0·70	—
9	Margosa poonac	Batticaloa	14·4	68·9	16·7	5·3	—	—	—
10	Tea sweepings	Panangala	10·4	69·1	20·5	2·8	0·41	1·78	1·38
11	Barnacles	Colombo	—	—	—	0·45	0·11	—	46·0
12	Ship's bottom scrapings	Air-dry, Colombo	—	—	—	1·49	0·97	—	—
13	Potash manure	Crude, Madampe	6·43	—	—	—	—	23·8	—
14	Potash manure	Concentrated, Madampe	1·71	—	—	—	—	38·0	—
15	Citronella ash	Mapalana	2·39	—	97·61	—	0·95	10·60	3·30

TABLE II

Analyses of Green Manures, Composts and Composting Materials

No.	Sample	Nature and Origin	Moisture	Organic Matter	Ash	Nitrogen	Phosphoric Acid	Potash	Lime
			%	%	%	%	%	%	%
1	*Mimosa bracaatinga*	Leaves and tender twigs, Passara	65·5	32·8	1·7	1·07	0·14	0·49	0·36
			—	*95·1*	*4·9*	*3·08*	*0·40*	*1·41*	*1·04*
2	*Albizzia sumatrana*	Leafy material, Passara	61·0	37·2	1·8	1·47	0·39	—	—
			—	*95·3*	*4·7*	*4·71*	*1·0*		
3	Salvinia weed	Fresh, Colombo	8·93	6·1	4·6	0·09	0·02	0·16	0·04
			—	*56·7*	*43·3*	*0·84*	*0·21*	*1·46*	*0·39*
4	Salvinia compost	Fresh, Negombo	52·3	9·1	38·1	0·27	—	—	—
			—	*19·2*	*80·8*	*0·57*	—	—	—
5	Water hyacinth	Air-dry	9·4	78·4	12·2	0·58	0·53	2·45	2·80
			—	*86·5*	*13·5*	*0·64*	*0·78*	*2·65*	*3·10*
6	Citronella grass	Air-dry, Mapalana	15·2	79·6	5·2	0·65	0·01	—	0·26
			—	*93·9*	*6·1*	*0·78*	*0·01*	—	*0·31*
7	Citronella *spent* grass	Air-dry, Mapalana	15·6	79·3	5·1	1·11	0·02	—	0·22
			—	*93·9*	*6·1*	*1·32*	*0·02*	—	*0·26*
8	Papyrus	Fresh, Up-country	80·0	18·9	1·3	0·13	—	—	—
			—	*93·4*	*6·6*	*0·69*	—	—	—
9	Compost	Moist, Walpita Farm	58·2	14·2	27·6	0·57	0·35	0·25	0·64

Figures in italics refer to percentages on moisture-free basis.

TABLE III

Analyses of Feedingstuffs

No.	Sample	Nature and Origin	Moisture	Protein	Fat	Carbo hydrates	Fibre	Ash	Lime	Phosphoric acid
			%	%	%	%	%	%	%	%
1	Gingelly poonac	Colombo, hydraulic pressed	8·85	32·62	13·22	23·63	5·55	16·13	2·81	1·00
2	Gingelly poonac	Colombo, expeller pressed	9·42	33·30	8·29	35·56	1·78	11·65	—	—
3	Dhal dust and husks	Anuradhapura, by-products of milling	11·59	17·81	2·57	56·84	5·39	5·80	—	—
4	"Chuni"	India, by-products of milling pulses	14·22	21·48	1·00	55·15	3·22	4·93	—	—
5	Kurakkan straw	Nalanda	13·78	4·49	0·97	42·75	29·25	8·76	1·05	0·46
6	Kurakkan chaff	Up-country. by-product of milling earheads	12·41	5·42	1·0	51·34	20·22	9·61	—	—
7	Tamarind seed	India, roasted and shelled	6·50	15·81	5·99	67·49	0·19	4·02	—	—
8	Maize "cake"	India, hulls of grain	10·80	6·77	2·71	60·48	15·50	3·74	—	—
9	"Chillan"	India, rice husks and bran	8·73	4·68	3·22	29·88	34·69	18·85	—	—
10	Fish meal	Ambepussa, locally dried, with bones	18·3	41·25	8·43	—	—	31·48	6·61	3·87
11	Fish meal	Ambepussa, without bones	27·94	44·82	6·81	—	—	19·66	2·95	2·80
12	Netheli fish (*Halmesso's*)	Market sample	13·64	61·80	2·84	—	—	21·62	3·65	2·48

TABLE IV

Analyses of Pasture Grasses and Fodders

No.	Sample	Nature and Origin	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash	Lime	Phosphoric acid
			%	%	%	%	%	%	%	%
1	*Axonopus compressus* (Broad leaf carpet grass)	Pasture grass, leaves only, Peradeniya	69·10	4·21	0·29	17·18	6·91	2·31	0·16	0·15
			—	*13·62*	*0·94*	*55·60*	*22·38*	*7·46*	*0·51*	*0·50*
2	*Axonopus affinis* (Narrow leaf carpet grass)	Pasture grass, leaves with flowering stalks, Peradeniya	66·60	4·23	0·34	17·49	8·84	2·50	0·24	0·13
			—	*12·66*	*1·00*	*52·38*	*26·48*	*7·48*	*0·73*	*0·38*
3	*Lolium subulatum* (Wimmera rye grass)	Annual pasture grass, in flower, limed area, Bopatalawa	69·80	2·39	0·27	17·66	7·89	1·99	0·21	0·17
			—	*7·73*	*0·89*	*58·67*	*26·13*	*6·58*	*0·69*	*0·53*
4	Maize plant	Fairly fresh, up-country	61·93	2·11	0·25	20·54	10·99	4·18	—	—
			—	*5·54*	*0·66*	*53·95*	*28·87*	*10·98*	—	—

Figures in italics are percentage on moisture-free basis.

MEETINGS, CONFERENCES, &c.

RUBBER RESEARCH SCHEME (CEYLON).

MINUTES OF THE SEVENTY-FIFTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE SECRETARIAT, COLOMBO, AT 2.30 P.M. ON MONDAY, JUNE 11, 1945.

Present.—Mr. L. J. de S. Senevíratne, C.C.S. (in the Chair), Col. C. J. D. Lanktree, C.C.S. (Acting Deputy Financial Secretary), Mr. T. Amarasuriya, M.S.C., Mr. W. N. de Alwis, Mr. W. P. H. Dias, J.P., Mr. A. M. Clement Dias, Mr. F. J. C. de Mel, Mr. R. P. Gaddum, Mr. F. H. Griffith, M.S.C., Mr. R. J. Hartley and Mr. R. C. Kannangara, M.S.C.

Mr. M. W. Philpott, Acting Director, was present by invitation.

An apology for absence was received from Mr. L. P. Gapp.

1. MINUTES

(*a*) *Confirmation.*—Draft minutes of the meeting held on March 12, 1945, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) *Appointment of Research Assistants.*—The financial position in connection with the proposal to appoint 4 research assistants was considered and it was agreed that steps be taken to make the appointments.

2. BOARD

The Chairman reported the following changes in the membership of the Board since the last meeting :—

(*a*) Messrs. A. M. Clement Dias and F. J. C. de Mel had been nominated by the Low-Country Products Association for three years from May 19, 1945, in place of Messrs. W. N. Gunawardena and J. L. D. Peiris, whose periods of membership had expired.

(*b*) Mr. W. H. Attfield had resigned and Mr. R. P. Gaddum had been nominated in his place by the Ceylon Estates Proprietary Association with effect from May 2, 1945.

(*c*) Mr. W. P. H. Dias had been renominated as a representative of small holders for a further period of three years from June 10, 1945.

A vote of appreciation of the services of the outgoing members was passed.

3. EXPERIMENTAL COMMITTEE

(*a*) *Membership.*—Agreed that Mr. F. J. C. de Mel should act for Mr. R. C. L. Notley as a member of the Committee.

(*b*) *Recommendation made at meeting held on April 30, 1945 :—*

Brown Bast K. P.—The recommendation that a Brown Bast K. P. be appointed at Dartonfield on the approved salary scale was approved.

(*c*) *Recommendations made at meeting held on June 11, 1945 :—*

Tenders for buildings and Hedigalla cart road.—As recommended by the Committee, a sub-committee was appointed to consider the tenders and award suitable contracts.

Arrangements for supervision of construction of the buildings and cart road were decided on.

4. REPORTS

(*a*) *Annual Report for 1944* was adopted.

(*b*) *Director's report for the 1st quarter, 1945*, was adopted.

5. ACCOUNTS

(*a*) *Statement of Receipts and Payments for the 4th quarter, 1944* (*C.P. 1200*)—was approved.

(*b*) *Dartonfield, Nivitigalakele and Hedigalla Accounts for December, 1944*—were tabled.

(*c*) *Balance Sheet and Income and Expenditure Account for 1944* (*C.P. 1204*).—The Chairman reported that the Auditor-General's report had not yet been received. The accounts were adopted subject to audit.

(*d*) *Over-expenditure and savings on votes for 1944.*—A statement showing details of over-expenditure and savings on votes for 1944 was considered and supplementary votes passed to cover the over-expenditure.

(*e*) *Revotes of 1944 estimates.*—Unexpended balances of 1944 capital votes were revoted as required.

(*f*) *Inventory Report for 1944* was adopted.

6. STAFF

(*a*) *Director.*—Reported that Mr. T. E. H. O'Brien, Director, had left the Island on six months' leave on May 15, 1945.

(*b*) *Chemist.*—Reported that Mr. M. W. Philpott, Chemist, had returned to the Island and resumed duties on April 20, 1945.

7. LONDON ADVISORY COMMITTEE

Agreed that the Board's contribution for 1946 should be half-share of the Committee's expenditure for the year.

8. PUBLICATIONS

The following publications were tabled :—

(1) Combined Quarterly Circular for 1944.
(2) Advisory Circular No. 25.
(3) Second Supplement to Advisory Circular No. 17.
(4) Special Circular.

The meeting then terminated.

DRAFT MINUTES OF THE 4TH MEETING OF THE PADDY ADVISORY BOARD.

THE 4TH MEETING OF THE PADDY ADVISORY BOARD WAS HELD AT ELEPHANT PASS RESTHOUSE AT 10.40 A.M. ON WEDNESDAY, FEBRUARY 7, 1945. THE MEETING WAS CONTINUED ON THURSDAY.

The Chairman, Mr. G. V. Wickramasekera, Paddy Officer, presided and the following members were present. Messrs. U. B. Alawwa, P. B. Bandaranayake, R. H. de Mel, Gate Mudaliyar Kariappar, V. Subasinghe, Rev. Fr. L. W. Wickremesinghe and Mr. R. Ratnasabapathy, Acting Secretary.

Mr. A. M. Clement Dias had intimated his inability to attend the meeting.

The Chairman in introducing Mr. V. Subasinghe extended him a hearty welcome to the Board.

CONFIRMATION OF THE MINUTES

The minutes of the 3rd meeting of the Paddy Advisory Board held on June 28, 1944, copies of which had been sent to all members, were confirmed.

ACTION TAKEN ON THE DECISIONS OF THE PREVIOUS MEETINGS

The Chairman read a statement of action taken on the proceedings of the previous meetings.

The following is a summary of the statement :—

PRICE OF PADDY

Mr. R. H. de Mel's resolution " that in return for the surrender of paddy at a fixed price, Government should make available to the Paddy growers, both cultivators and labourers, at fixed prices, sufficient quantities of their requirements of textiles, subsidiary foodstuffs, kerosene oil and other essentials on a graduated scale proportional to the production per acre and the percentage of this surrendered. " was forwarded to the Director of Agriculture for necessary action.

TWO SEASON CULTIVATION AND THE MAXIMUM QUANTITY ALLOWED TO CILTIVATORS

Mr. R. H. de Mel's resolution " that where it is customary for fields to be cultivated with one long-termed crop only once a year, growers should be allowed to retain sufficient paddy for their consumption for 12 months, provided that quantity does not exceed 100 bushels." was forwarded to the Director of Agriculture for necessary action.

WET PADDY AT AMBALANTOTA

Rev. Fr. Wickremesinghe's resolution on par-boiling of wet paddy in the Hambantota district was forwarded to the Director of Agriculture for necessary action.

Mr. De Mel commented that although resolutions are passed from time to time and forwarded to the authorities concerned, the tendency appears to be to take little or no action on them. He referred for example to the resolution passed at the last meeting of the Board, regarding the payment of low prices for paddy which had got wet in the field and resulted in a higher percentage of broken grain when milled raw, as is the general practice in the Southern

Province. If, however, the paddy was par-boiled before milling the percentage of broken grain would be very considerably reduced, and the cultivator need not be penalized for something over which he had no control.

Gate Mudaliyar Kariappar said that in the Batticaloa district paddy was purchased on the threshing floor itself and that no such reductions in price were made by Government. Mr. de Mel said that still at Tissa, the Mill decides the price to be paid to the farmers. He moved " that action proposed or taken on resolutions passed by this Board, should be communicated to the Board by the authorities concerned. " This was seconded by Rev. Fr. Wickremasinghe and was unanimously adopted.

Gate Mudaliyar Kariappar formally moved " that with a view to imparting Agricultural Education by Cinema, the Department of Agriculture should send out its van to the farming villages of the Batticaloa district in the month of August every year. "

The Chairman stated that he had taken up this matter with the Agricultural Officer, Propaganda, who had replied as follows : " My present equipment is poor. For the duration of the war we will not be able to get any films taken or get an up-to-date van and cinema material. We can go over to Batticaloa in August if Gate Mudaliyar Kariappar desires it." Gate Mudaliyar Kariappar said that the last occasion on which a propaganda show was held was about eight years ago when the Chairman in his capacity as Economic Botanist addressed a gathering there.

In view of the explanation of the Propaganda Officer the Board decided that the resolution need not be discussed further, but suggested that shows should be held annually.

On leading the discussion on the resolution " that this Board appeals to the Hon'ble the Minister for Agriculture and Lands to be kind enough to take steps to amend the Irrigation Ordinance, so that provision may exist for paddy lands sold for default of payment of irrigation rates and bought in by the Crown to be redeemed within a period of 5 years by the owner or in the event of his decease, by his heirs by payment of all Crown dues. " Mudaliyar Kariappar stressed on the impotance of the resolution and said that if the owner was alive he could redeem the lands sold for default of payment of irrigation rates but that in the event of his death, his heirs had no chance of redeeming such lands according to recent interpretation of the Ordinance referred to. The Board felt that this is an injustice to the heirs of the cultivator who had defaulted. The Board agreed that in the first instance, enquiries should be made whether such an interpretation could be placed on the Irrigation Ordinance referred to.

In commenting on how the paddy cultivator is affected by the Internal Purchase Scheme, Mr. P. B. Bandaranayake quoted the old saying " the ploughman is fit to rule the Kingdom " but that today under the Internal Purchase Scheme, the cultivator is termed a rogue and by many other harder terms. As producer of the most essential commodity of the people of the country at this time of food shortage, he must be encouraged, won over and well cared for. He said that he was not stressing on the subject, as it had been fully discussed by members at the last meeting and moved an amendment on Mr. R. H. de Mel's resolution on the same subject at the last meeting to read as follows : " that in return for the surrender of paddy at a fixed price, Government should make available to the paddy growers, both cultivators and labourers, sufficient quantities of their requirements of textiles, subsidiary foodstuffs, kerosene oil and other essentials at reasonable prices. "

Mr. Subasinghe seconded the amendment.

The Chairman enquired whether it would not meet the case, if we pursue the matter and enquire what action has been taken by the authorities concerned on Mr. de Mel's resolution passed at the last meeting. The Board unanimously agreed to this and Mr. Bandaranayake withdrew his amendment.

Arising out of the above discussion the question of stabilizing the price of paddy was discussed. Gate Mudaliyar Kariappar's resolutions and comments at the last meeting of the Central Board of Agriculture were read. As this question had been discussed at length at the

last meeting of the Paddy Advisory Board, Mr. R. H. de Mel proposed and Mr. V. Subasinghe seconded " that enquiries be made from the Director of Agriculture whether Government considers it possible to stabilize the price of paddy after the war." This was unanimously adopted.

The Chairman stated that he regrets that Mr. A. V. Kulasingam was not able to attend the meeting and give us the benefit of his experiences in paddy cultivation under the Karachchi Scheme. As one of the functions of the Board is to ascertain the problems which exist in important paddy producing areas and to suggest measures for the amelioration of existing conditions, the Deputy Director of Agriculture's speech at the inaugural meeting was read out by the Chairman. Mr. de Mel stated that the Deputy Director of Agriculture's suggestions exactly indicated the lines on which this Board should function and suggested that at the next meeting of this Board each member should present a short memorandum and a well considered scheme for the development of the paddy industry should be drawn up.

The Chairman then read a report on the work done at the Paddy Station, Paranthan, with special reference to systems of cultivation adopted and particulars of varieties grown. Mr. de Mel complimented the Chairman on the interesting paper and stated that similar valuable infromation should be compiled and collected from all stations.

The Chairman next read a paper on " Tractor Cultivation of the Fields in the Batticaloa District " by the Agricultural Officer, Batticaloa. Gate Mudaliyar Kariappar commented that the yields stated in the paper were calculated from the so-called random selection of check plots and that the calculated yields are misleading and moved " that in view of the fact that the yields have been calculated on yields of small plots selected at random, the Board would wish to know the actual yield obtained from the total area worked by tractors and the total cost of production." This was seconded by Mr. R. H. de Mel and was unanimously adopted.

Mr. de Mel said that our systems should change slowly and that his resolution at the previous meeting regarding organizing Small Holding Demonstration Farms round about Experimental Stations and the organization of Private Seed Farms should receive the early attention of the Assistant Government Agents (Emergency). The Board unanimously agreed that the Paddy Officer should take up the organization of Private Seed Farms and Demonstration Centres.

Mr. V. Subasinghe enquired who was in charge of the present paddy experiments at Tabbowa. The Chairman replied that the Divisional Agricultural Officer, North-Western, was in charge.

Gate Mudaliyar Kariappar suggested that a separate Paddy Department should be established as it was essential to co-ordinate work and that he was moving this at the next meeting of the Central Board of Agriculture.

Mr. de Mel suggested that Paddy Research and Development Institute, like the Rubber and Tea Research Institutes, should be formed with a Director at its head.

Mr. V. Subasinghe remarked that this Board should be given executive powers and should have its own funds to do research, organize co-operative farms, marketing facilities &c., and moved " that this Board should draft a constitution and put up to Government proposals to empower the Board with executive powers and to control the Paddy Research and Development Institute." It was agreed to discuss this in detail at the next meeting. In this connection the Chairman read out Mr. Tyson's Bill at the Central Assembly, New Delhi, on " Improvement and Development of Paddy Cultivation in India." The members requested that this paper be circulated to all members before the next meeting.

The discussion was adjourned at 1.45 P.M.

In the afternoon the members visited the Karachchi Scheme and were conducted by the Agricultural Officer, Northern Province, through the Cattle Farm, Kilinochchi, and Lady Ramanathan's Paddy Lands, Kilinochchi, leased and worked by Government. Later they visited the Paddy Station, Paranthan, and were conducted through the station by the Paddy Officer.

The meeting was resumed at 9.50 A.M. on the 8th instant. Mr. W. P. A. Cooke, the Agricultural Officer, Kilinochchi, and Mr. A. C. Ponnambalam, a resident cultivator under the Karachchi Scheme, were present as visitors.

Mr. R. H. de Mel moved "that this Board expresses its appreciation on the highly efficient manner in which the Paranthan Paddy Station is run which reflects very great credit on all concerned in its direction and management."

The Board felt that the station was remarkedly free from weed fall and the almost total freedom from pests and diseases. Uniformity of growth was very noticeable. As regards experiments those designed to ascertain the optimum time of application of fertilizers was felt to be one that should give valuable results. The duty of water experiment also deserves special commendation. The results obtained would be particularly useful for permitting the cultivation of increased areas under tank irrigation.

Mr. de Mel moved "that in view of the obvious benefits obtained from harrowing the growing rice crop at Paranthan Paddy Station, this Board strongly recommends that Government should direct all officers in charge of Government Paddy Stations to make harrowing the growing rice crop a standard practice." This was seconded by Mr. V. Subasinghe and unanimously adopted. It was further pointed out that the adoption of the system of harrowing the growing rice crop would result in the introduction of implemental tillage and the elimination of weeds in areas where these practices are now not obtaining.

Mr. de Mel questioned as to how cattle are maintained on this station and was informed that they were stall fed as there was no pasture reserves. After discussion the Board recommended that Paddy Stations should be mixed farms with cattle and the economics of growing fodder and pasture for cattle under irrigation should be determined.

ANY OTHER BUSINESS

(1) Petrol Coupons. It was agreed that members attending the Board meeting who require petrol coupons to travel to and from the Railway Station to their residence should apply to the Chairman who will communicate with the authorities concerned.

(2) Gate Mudaliyar Kariappar enquired whether a resolution should not be passed requesting Government to pay for seed paddy produced on Private Seed Farms a price 50 per cent. over and above the control price. The Chairman stated that the Hon'ble the Minister for Agriculture and Lands is not in favour of sanctioning two prices for paddy but that he has sanctioned the payment of a subsidy up to Rs. 15 per acre for improvements effected on farms which would serve as demonstration centres.

(3) Gate Mudaliyar Kariappar requested that the Model Chinese Water Wheel, demonstrated at Paranthan Paddy Station, be loaned to him to enable him to get some constructed by local carpenters.

Mr. A. C. Ponnambalam then interviewed the Board and discussed several difficulties experienced by cultivators. The Board offered suggestions to enable him to secure redress.

A vote of thanks moved by Rev. Fr. Wickremesinghe to the Government Agent, N. P., for permitting the use of the Elephant Pass Rest House for holding the meeting was unanimously carried.

TIME AND PLACE OF NEXT MEETING

It was decided that the next meeting should be held at Colombo at the Chamber of Commerce building on April 26 and 27, 1945.

The meeting then terminated at 2 P.M. with a vote of thanks to the Chair.

By order,
R. RATNASABAPATHY,
Acting Hon. Secretary, Paddy Advisory Board.

Paddy Office,
Peradeniya, February 24, 1945.

DRAFT MINUTES OF THE 5TH MEETING OF THE PADDY ADVISORY BOARD

THE 5TH MEETING OF THE PADDY ADVISORY BOARD WAS HELD AT THE CHAMBER OF COMMERCE BUILDING AT 2.15 P.M. ON THURSDAY, APRIL 26, 1945. THE MEETING WAS CONTINUED ON FRIDAY.

The Chairman, Mr. G. V. Wickramasekera, Paddy Officer, presided and the following members were present : Messrs. R. H. de Mel, U. B. Alawwa, V. Subasinghe and Mr. T. M. P. Tennekoon, Acting Secretary. Dissawa P. B. Bulankulame intimated his inability to attend the meeting on April 26, but that he would be present on the following day.

Rev. Fr. L. W. Wickremesinghe and Messrs. A. M. Clement Dias and P. B. Bandaranayake intimated their inability to attend the meeting.

CONFIRMATION OF THE MINUTES

The minutes of the 4th meeting of the Paddy Advisory Board held on February 7, 1945, copies of which had been circulated to all members, were confirmed.

ACTION TAKEN ON THE DECISIONS OF THE PREVIOUS MEETINGS

The Chairman read a statement of action taken on the proceedings of the previous meetings and also tabled the Director of Agriculture's letter No. F. P. 375 of March 22, 1945, wherein he suggests that matters which did not come within his purview be dealt with direct.

The following is a summary of the statement :

AMENDMENT OF THE IRRIGATION ORDINANCE

The resolution by Gate Mudaliyar Kariappar, " that this Board appeals to the Hon'ble the Minister for Agriculture and Lands to be kind enough to take steps to amend the Irrigation Ordinance so that provision may exist for paddy lands sold for default of payment of irrigation rates and bought in by the Crown to be redeemed within a period of 5 years by the owner or in the event of his decease by his heirs by payment of all Crown dues " was referred to the Hon'ble the Minister for Agriculture and Lands, who acknowledged receipt and stated that a further communication will be sent in due course.

STABILIZE THE PRICE OF PADDY AFTER THE WAR

Mr. de Mel's resolution, " that enquiries be made from the Director of Agriculture whether Government considers it possible to stabilize the price of paddy after the war," was forwarded to the Director of Agriculture who replied that this question falls outside his purview. The resolution was then forwarded to the Hon'ble the Minister for Agriculture and Lands.

TRACTOR CULTIVATION

Gate Mudaliyar Kariappar's resolution, " that in view of the fact that yields have been calculated on yields of small plots selected at random, the Board would wish to know the actual yields obtained from the total area worked by tractors and the total cost of production," was forwarded to the Director of Agriculture. The Director of Irrigation who was requested to send a report on the results of the tractor trials conducted by his Department has replied that a full report will be sent in due course.

Messrs. de Mel and Alawwa requested the Chairman to obtain figures of the Kahagama and Kopakulama trials.

HARROWING THE GROWING RICE CROP

Mr. de Mel's resolution, " that in view of the obvious benefits obtained from harrowing the growing rice crop at Paranthan Paddy Station this Board strongly recommends that Government should direct all officers in charge of Government Paddy Stations to make harrowing the growing rice crop a standard practice," was forwarded to the Director of Agriculture who has acknowledged receipt and replied that he has addressed the Divisional Agricultural Officers on the subject and action will be taken on receipt of their replies.

Mr. de Mel enquired whether the Paranthan Paddy Station was naturally free of weeds. The Chairman replied in the negative and stated that the comparative absence of weeds was due to systems of cultivation adopted on the station.

Mr. V. Subasinghe enquired whether the Jaffna soils in general were impregnated with salts and hence very little weed growth was present. The Chairman replied that tracts beyond Elephant Pass and in the coastal belt were rainfed and unless thorough preparatory tillage is done, it is difficult and costly to control weed growth.

PUBLISHING COST ACCOUNTS

Gate Mudaliyar Kariappar's suggestion that the cost of production of each station for each season should be published for the information of the adjoining land owners was forwarded to the Director of Agriculture. The Chairman tabled the Director of Agriculture's instructions to the Departmental Officers requesting them to post up in prominent places the Cost of Production Accounts in each station for each season.

A memorandum on a " Scheme for the Development of the Paddy Industry in Ceylon " submitted by Mr. V. Subasinghe was read. In it he suggests a Paddy Board—members to be appointed by the Hon'ble the Minister for Agriculture and Lands, to be entrusted with the task of improving and developing the Paddy Industry.

Mr. R. H. de Mel mentioned that a Rice Advisory Board exists in India. The Chairman then read some literature received from Mr. K. Vaithianathan, Commissioner, Ceylon Government Supplies, on reports of some of the Indian Rice Development Schemes. It was agreed that these papers should be circulated amongst the members of the Board.

Mr. de Mel then made mention of the success of the Agricultural Products Sales Society of Jaffna.

The Chairman then suggested a Scheme for the Development of the Paddy Industry in Ceylon to be worked by the Department of Agriculture.

It was agreed that Mr. Subasinghe's memorandum and the Scheme prepared by the Chairman be circulated amongst the members before the next meeting of the Board.

The discussion was adjourned at 4 P.M.

The Meeting was resumed at 10·15 A.M. on Friday, April 27, 1945.

The Chairman, Dissawa P. B. Bulankulame, Messrs. R. H. de Mel, V. Subasinghe and the acting Secretary were present.

Mr. U. B. Alawwa intimated his inability to be present owing to unavoidable circumstances.

Before proceedings with the business of the day the Chairman, on behalf of the Board, congratulated Dissawa Bulankulame on his success at the recent State Council Election in being returned by an unprecedented majority testifying to his popularity and the confidence the electorate has in him.

After preliminary discussions on the proceedings of the previous day, the Dissawa suggested putting off the consideration of a Scheme for the Development of the Paddy Industry for the next meeting.

Mr. Subasinghe suggested that the Co-operative Farming Societies mentioned in his memorandum be put into operation at one centre. It was agreed that the Chairman should

discuss this question with the Commissioner for Co-operative Development and the Land Commissioner and it was agreed that this motion be brought up at the next meeting of the Board and that the Chairman should make preliminary enquiries with a view to working this scheme in the Batalagoda area.

ANY OTHER BUSINESS

It was suggested that the next meeting be held at Hambantota and that the Board should visit the important paddy schemes in the district and obtain first hand information on the large scale tractor trials conducted there and that enquiries be made from the members if they could attend the meeting.

TIME AND PLACE OF NEXT MEETING

It was decided that the next meeting should be held at Hambantota Rest House on August 23, 24 and 25, 1945. Since one meeting of the Board was not held last year due to the absence of the Chairman on leave in India, it was decided to enquire if the members would be able to meet in Colombo in late June to discuss the memoranda on the Paddy Development Schemes.

The meeting then terminated at 12·15 P.M. with a vote of thanks to the Secretary, Chamber of Commerce, proposed by Dissawa P. B. Bulankulame and seconded by Mr. R. H. de Mel for permitting the use of the room.

By order,

T. M. P. TENNEKOON,
Acting Secretary,
Paddy Advisory Board.

Peradeniya, May 17, 1945.

3—J. N. A. 54646 (9/45)

COCONUT RESEARCH SCHEME BOARD OF MANAGEMENT.

DRAFT MINUTES OF THE 70TH MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEMES, HELD ON MONDAY, OCTOBER 9, 1944, IN THE OFFICE OF THE DEPUTY FINANCIAL SECRETARY, NEW SECRETARIAT, COLOMBO.

Present.—Mr. L. J. de S. Seneviratme, C.C.S., Acting Director of Agriculture (Chairman), Mr. C. E. Jones, C.C.S., Deputy Financial Secretary, Mr. S. Pararajasingham, J.P., Chairman, L.C.P.A., Mr. O. B. M. Cheyne, Mr. C. A. M. de Silva, Mr. D. D. Karunaratne, J.P., Mr. W. P. H. Dias, J. P., Mr. Graham Panditteseker, J.P., U.M., Mr. Dudley Senanayake, M.S.C., Mr. S. Dharmaratnam, M.S.C., Dr. R. Child, Director of Research and Mr. S. C. Kahawita, (Secretary).

(1) MINUTES.

The Minutes of the previous meeting held on September 18, 1944, which had been circulated to the Members (C.P. No. 526) were confirmed.

(2) STAFF.

(*a*) *Leave Application of Senior Clerk.*—The Chairman said that the Senior Clerk has asked for 18 days leave on the occasion of his marriage. He is entitled to 14 days leave *per annum*, but since 1942 he has taken only 19 days leave. As the Director of Research recommended this leave the Chairman suggested that it be granted. The Board approved.

(*b*) *Allowance to the Field Assistants to the Geneticist and Soil Chemist* .—The Chairman said that on the instructions of the Board (Minutes 68th meeting, C.P. 521, para. 2c) he had circulated among the members his observations on the recommendation of the Director of Research (C.P. 527) to pay an allowance to the Field Assistants. On the Chairman's recommendations the Board resolved that Mr. C.W. S. de Silva, Senior Field Assistant, and Mr. R. W. Senaratne, Field Assistant to the Geneticist, be paid an allowance of Rs. 30 and 20 *per mensem* respectively from July 1, 1944. With reference to the Director of Research's recommendation in para. 5 of the Chairman's circular (C.P. No. 527) the Board resolved to pay Mr. M. G. Fonseka a retrospective allowance of Rs. 30 per month from July 1 to December 31, 1943, the period during which the Soil Chemist was on leave and Mr. Fonseka was in charge of the Department (under the supervision of the Director of Research).

(3) FINANCE.

(*a*) *Replacement of Accumulators.*—The Chairman tabled a letter received from the Department of Electrical Undertakings in reply to his letter written on the instruction of the Board (Minutes 68th meeting C.P. 521, para. 5 (*a*)).

The Board authorised the Director of Research to get in direct contact with the Chief Engineer, Department of Electrical Undertakings. The Director of Research was instructed to write the old plates off and replace from Depreciation fund in consultation with the Deputy Financial Secretary.

(*b*) *Estimates for 1945* were approved with the following additions:—Estimates of Rs. 1,200 for a Technical Assistant to the Geneticist was approved, and the estimate of Rs. 1,500 for scientific books and periodicals was raised to Rs. 2,000.

4. ANY OTHER BUSINESS.

(*a*) It was decided that arrangements should be made with the Visiting Agent to visit the estates in February and July rather than in October and May, if this could be arranged.

(*b*) It was resolved that the Revised Memorandum should be duplicated or printed and circulated to all the interested bodies to whom the 1939 Memorandum was circulated with the addition of the Ceylon Estates Proprietory Association, giving them one month to send in their suggestions and recommendations.

(*c*) The Chairman read a letter sent to the Director of Research by the Minister for Labour, Industry and Commerce with reference to the Cost of Production of Coconuts. The Director of Research was authorised to make a report to the Minister on the subject.

The meeting terminated at 12.35 P.M.

By order,

S. C. KAHAWITA,
Secretary,
Board of Management,
Coconut Research Scheme.

Coconut Research Scheme,
Lunuwila, October 23, 1944.

COCONUT RESEARCH SCHEME BOARD OF MANAGEMENT.

DRAFT MINUTES OF THE 71ST MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT 10.00 A.M. ON MONDAY, JANUARY 22, 1945, IN THE ROOM OF THE DEPUTY FINANCIAL SECRETARY, NEW SECRETARIAT, COLOMBO.

Present.—Mr. L. J. de S. Seneviratne, C.C.S., Acting Director of Agriculture (Chairman), Mr. C. E. Jones, C.C.S., Deputy Financial Secretary, Mr. S. Pararajasingham, J.P., Chairman, L.C.P.A., Sir Wilfred de Soysa, W. P. H. Dias, J.P., Mr. Graham Panditteseker a, J.P., U.M., Mr. Stanley Dias, Mr. C. A. M. de Silva, Mr. W. V. D. Pieris, Geneticist, representing the Director of Research, Mr. S. C. Kahawita, Secretary.

An apology for absence was received from Mr. O. B. M. Cheyne.

1. MINUTES.

The minutes of the previous meeting held on October 9, 1944, which had been circulated to members (C.P. No. 531), were confirmed.

2. CHANGES IN MEMBERSHIP OF THE BOARD OF MANAGEMENT.

At the request of Mr. W. P. H. Dias and other members, the Chairman moved a vote of appreciation on the services rendered to the Board by Mr. D. D. Karunaratne, who had represented the small-holders from September 1, 1935, to October 31, 1944, and Mr. C. A. M. de Silva, who had been a representative of the Low Country Products Association from November 1, 1941, to October 31, 1944. The Chairman welcomed Mr. de Silva back on the Board as a Small-holders' Representative nominated by H. E. the Governor. The Chairman also welcomed Mr. Stanley Dias as a representative of the L.C.P.A. on the Board.

3. STAFF—JUNIOR STAFF.

(i.) Resignation of Mr. W. D. Frederick, Conductor, Bandirippuwa Estate, in November last year, for the purpose of going into more remunerative employment as an Estate Superintendent elsewhere, was reported. The payment of the amount to his credit in the Provident Fund, in accordance with the rules governing that Fund, was approved.

(ii.) Mr. Pieris stated that it had become very difficult to carry on the work of his Division owing to the reduction in the number of Nursery Attendants caused by the resignation of W. P. Boteju and that it had not been found possible to secure the services of a suitable man on the initial salary of the Nursery Attendants' scale. The only satisfactory man that had come forward was one H. W. Fernando who was at present employed in a military establishment on a salary of Rs. 29.50 per week; and that although he was shown the advantages of permanent employment offered by the Scheme, he was not prepared to accept the vacant post at a lower salary than Rs. 40 a month, exclusive of the Dearness Allowance. H. W. Fernando's level of education was higher than those of the Nursery Attendants now in service and he also had the further advantage of having received a training in general estate practice under Mr. A. J. C. Peiris of Kirimetiyane Estate, Lunuwila. Subsequent to that training, he had also gained practical experience as Conductor-in-Charge of an estate in Rambukkana.

In the circumstances, Mr. Pieris strongly recommended that H. W. Fernando should be appointed on the maximum salary of the Nursery Attendants' scale plus Dearness Allowance or on an equivalent salary. This was approved by the Board.

(iii.) Mr. Pieris drew attention to correspondence that had passed between the Director of Research and the Chairman and reported that the work of the Division of Soil Chemistry had now developed to a point where the appointment of a third Field Assistant had become an urgent necessity. It had been the intention of the Director of Reserach, when the Superintendent was re-transferred to Ratmalgara in September last year, and the Conductor of Ratmalgara brought back to Bandirippuwa, to employ the other Conductor at Bandirippuwa Estate (Mr. W. D. Frederick) as a Floating Field Assistant between the three Research Divisions, with a preferential call on his services allowed to the Soil Chemist's Division. He had, in fact, under this arrangement, been employed mostly in the Division of Soil Chemistry and had helped to relieve the other two Field Assistants of that Division, who were hardly able to cope with the increasing volume of work. Mr. Frederick's resignation had restored the unsatisfactory *status quo* of the Division and it was therefore urged that a new appointment should be made immediately. Since provision had been in the Memorandum for an Additional Field Assistant to the Division of Soil Chemistry, the Board decided that the appointment be made forthwith. The Director of Research was authorised to advertise the post and to make the appointment, if necessary, on a salary higher than the minimum of the scale for Field Assistants in relation to the qualifications of the selected applicant and with the approval of the Board.

4. FINANCE.

(*a*) *Receipts and Payments for 3rd Quarter, 1944.*—A statement of Receipts and Payments for the 3rd Quarter, 1944, which had been circulated to members (C.P. 530) was approved.

(*b*) *Provident Fund.*—The Chairman reported that he had informed the Hon. Minister for Agriculture and Lands that the draft bill to amend the Cocnut Research Ordinance, giving effect to the new rules governing the Provident Fund, was in order and met with the requirements of the Board.

5. BUILDINGS.

The approval of the minutes of the 26th meeting of the Buildings Sub-Committee, which had been circulated to members (C.P. No. 533) was confirmed.

6. ESTATES.

Field Experiment at Kumballoluwa Estate, Veyangoda.—Reference was made to correspondence that had passed between the Director of Research and the Agents for Kumbalolluwa Estate, Messrs. Dias Pieris & Co., in connection with the decline of crops in some of the Scheme's experimental blocks on that estate. The Agents had recommended the termination of the experiment, but the Director of Research had met them and, as the closing down of the experiment was untimely, had suggested a satisfactory arrangement whereby the Board might consider the payment of an amount, calculated annually, by way of compensation for loss of crops due to experimental treatment. After a full discussion, in which the views of Mr. Stanley Dias, a partner of Messrs. Dias Pieris & Co. were obtained, the Board agreed to this arrangement.

7. GENERAL.

(*a*) *Memorandum on the Future of the Coconut Research Scheme.*—The unanimous approval of the Board had been obtained by the circulation of papers for the distribution of the Memorandum as a printed document and the estimate for printing of Rs. 375 had also received the Board's sanction. This charge was to be met from the Printing and Advertising Vote.

The Chairman referred to the Method of Providing Funds proposed in the Memorandum, viz., by means of a cess on exported coconut products based on 12½ cents per 1,000 nuts, supplemented by a Government contribution varying in such a manner as to ensure a total annual income to the Scheme of Rs. 150,000 and suggested that alternative proposals should be put forward in the Memorandum to ensure the whole of the required annual income solely by means of an export cess without having recourse to the present annual Government grant or to an

increased and varying grant as proposed in the Memorandum. The Board agreed with this view and instructed the Director of Research to evaluate the amounts of such increased cess and insert the Chairman's suggestion in its appropriate place in the Memorandum.

(*b*) *Training of Students.*—Circulation Paper No. 352, embodying the correspondence that had passed between the Hon. Minister for Agriculture and Lands, the Chairman and the Director of Research, was discussed and it was resolved that the Chairman should inform the Hon. Minister that the Coconut Research Scheme, was not at present in a position, with the funds at its disposal, to undertake the training of students at its Research Stations, but that arrangements for such training of students could be made if the financial status of the Scheme were improved as proposed in the Memorandum on the future of the Coconut Research Scheme or, earlier, if special financial assistance for the purpose were to be provided by the Government.

(*c*) *Issue of Publications.*—A letter from the Secretary, Planters' Association, Kandy, forwarding a resolution of the Chilaw Planters' Association, relating to the necessity for giving wider publicity to the Scheme's work, and a reply thereto by the Director of Research were tabled. It was resolved that all suggestions of this sort from interested bodies should be collected and considered in relation to the Memorandum on the Future of Coconut Reserach Scheme.

8. **ANY OTHER BUSINESS.**

(*a*) *Mr. Graham Panditteseker's resolution regarding the Hot Air Drier at Ratmalgara Estate.*—All available information on the questions raised by Mr. Panditteseker with regard to the working of the Hot Air Drier at Ratmalgara had been circulated, (C.P.536), and Mr. Panditteseker was satisfied that the quality of the copra at present produced therein was not satisfactory and much inferior to the copra produced in the "Pearson Patent" Kiln at Bandirippuwa Estate. Mr. Panditteseker was, however, desirous that every possible effort should be made to improve the design of the Ratmalgara kiln in order to increase its output of which copra or, failing that, to devise another kiln of cheap construction to enable small-holders to produce this superior grade of copra which commanded a very high price before the war. It was agreed that the matter was worthy of further consideration.

The meeting terminated with an expression of thanks to Mr. Jones for the use of his room.

By order,

W. V. D. PIERIS,
for Director of Research,
Coconut Research Scheme.

Coconut Research Scheme,
Bandirippuwa Estate,
Lunuwila, February 2, 1945.

COCONUT RESEARCH SCHEME—BOARD OF MANAGEMENT.

DRAFT MINUTES OF THE 72ND MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT 11.00 A.M. ON FRIDAY, MARCH 23, 1945, IN ROOM NO. 202, NEW SECRETARIAT, COLOMBO.

Present.—Mr. L. J. de S. Seneviratne, C.C.S., Acting Director of Agriculture (Chairman), Col. C. J. D. Lanktree, C.B.E., E.D., C.C.S., Acting Deputy Financial Secretary, Sir Wilfred de Soysa, Mr. W. P. H. Dias, Mr. Stanley Dias, Mr. O. B. M. Cheyne, Mr. Graham Panditteseker a, J.P., U.M., Mr. C. A. M. de Silva, Dr. Reginald Child (Director of Research), Mr. S. C. Kahawita (Secretary).

1. MINUTES.

The minutes of the previous meeting held on Monday, January 22, 1945, which had been circulated to Members (C. P. 538) were confirmed.

2. STAFF.

(*a*) *The Director of Research's leave out of the Island.*—The Director of Research's application for 8½ months full pay leave out of the Island was approved, and the leave granted from May 1, 1945, or such later date as transport might be available. It was desired that Dr. Child should return about January, 1946, as negotiations regarding the Memorandum on the Future of the Scheme would then be coming up.

(*b*) *New Agreements of Senior Staff.* (i) *Director of Research.*—Depending upon a favourable report from the Deputy Financial Secretary on the financial position of the Scheme it was decided to offer the Director of Research a new contract to be dated from his resumption of duties after his return to the Island.

(ii) *Geneticist.*—The Board agreed to renew the contract of the Geneticist for a further period of 5 years dating from June 24, 1944.

(iii) *Soil Chemist.*—The Chairman reported that the new agreement of the Soil Chemist had been signed for a period of 2 years from January 1, 1944, embodying the conditions as laid down by the Board in C.P. 538 3*a* (I).

(*c*) *Technical Assistant to Geneticist.*—The Director of Research reported that only eleven applications had been received for the post of Technical Assistant to the Geneticist, and the standard of these was not high. It was decided to re-advertise the post, on the same terms as previously. In the event of applications being unsatisfactory, the Director of Research was authorized to appoint instead a third Field Assistant, subject to the approval of the Board

3. ESTATES.

Paddy Field on Ratmalgara Estate.—The Board approved of the extension of the paddy field at Ratmalgara Estate at the discretion of the Director of Research with the advice of the Superintendent. It was desired, however that a full report on the progress of the work be circulated and sanction sought in due course for any supplementary estimate required.

5. TRAVELLING RATES OF BOARD MEMBERS.

On the recommendation of the Director of Research it was decided that the travelling rates paid to Board Members be increased to 45 cents per mile as from and including the 72nd meeting.

7. **PRINTING.**

(*a*) *Memorandum on Future of the Coconut Research Scheme.*—(i) The Director of Research tabled a statement on the printing of the Memorandum on the Future of the Coconut Research Scheme. The Board agreed that the delay in printing was due to circumstances outside our control. The second proof (said the Director of Research) was expected to be ready on March 28th, and the final copies before the end of April.

(ii) It was mentioned by the Chairman that for the Scheme to obtain the yearly income envisaged in the Memorandum without a Government grant the cess on coconuts would have to be raised to 25 cents per 1,000 nuts or its equivalent on other products. The Director of Research mentioned that a footnote stating this had been included in the Memorandum.

(*b*) *Annual Report for 1943.*—The Chairman reported that the Hon. Minister for Agriculture and Lands had approved the printing as a Government Sessional Paper of the Annual Report for 1943. It was agreed to obtain 200 copies. The delay in publication was due to external circumstances.

8. **ANY OTHER BUSINESS.**

Mr. G. Panditteseker a's motion that an Industrial Chemist be appointed to the Scheme was deferred as this was already envisaged in the Memorandum on the Future of the Coconut Research Scheme.

By Order,

S. C. KAHAWITA,
Secretary,
Board of Management,
Coconut Research Scheme.

Lunuwila, April 19, 1945.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED APRIL 30, 1945

Province, &c.	Disease	No. of Cases up to date since Jan. 1, 1945	Fresh Cases	Deaths	Recoveries	Balance Ill	No. shot
Western Province	Rinderpest	123	28	57	49	13	4
	Foot-and-mouth	10	—	—	10	—	—
Colombo Municipality	Rinderpest	145	28	73	72	—	—
	Rabies	13	4	13	—	—	—
Colombo Quarantine Station	Rinderpest	658	252	658	—	—	—
	Anthrax	77	2	77	—	—	—
Southern Province	Hæmorrhagic Septicaemia	28	18	25	2	1	—
Northern Province	Rinderpest	408	84	376	—	5	27
North-Western Province	Rinderpest	326	134	208	47	50	21
Central Province	Foot-and-Mouth	46	10	2	35	—	9
	Anthrax	23	—	23	—	—	—
	Black quarter	12	4	12	—	—	—

Peradeniya, June 15, 1945.

T. M. Z. MAHAMOOTH,
Acting Deputy Director (Animal Husbandry) and
Government Veterinary Surgeon.

4——V. W. A 54046 (9/45)

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MAY 31, 1945

Province, &c.	Disease	No. of Cases up to date since Jan. 1, 1945	Fresh Cases	Deaths	Recoveries	Balance Ill	No. shot
Western Province	Rinderpest	204	81	125	61	13	5
	Foot-and-mouth	—	10	—	10	—	—
Colombo Municipality	Rinderpest	159	14	77	82	—	—
	Rabies	18	5	18	—	—	—
Colombo Quarantine Station	Rinderpest	741	83	741	—	—	—
	Anthrax	97	20	97	—	—	—
Northern Province	Rinderpest	576	168	343	129	28	76
Southern Province	Hæmorrhagic Septicaemia	39	11	11	23	2	—
	Rabies	1	1	1	—	—	—
North-Western Province	Rinderpest	599	273	320	178	72	29
Central Province	Foot-and-mouth	46	—	2	35	9	—

T. M. Z. MAHAMOOTH,
Acting Deputy Director (Animal Husbandry) and
Government Veterinary Surgeon.

Peradeniya, November 1, 1945.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JUNE 30, 1945,

Province, &c.	Disease	No. of Cases up to date since Jan. 1, 1945	Fresh Cases	Deaths	Recoveries	Balance Ill	No. shot
Western Province	Rinderpest	242	38	139	84	15	4
	Foot-and-mouth	10	—	—	10	—	—
Colombo Municipality	Rinderpest	774	33	774	—	—	—
	Rabies	99	2	99	—	—	—
Colombo Quarantine Station	Rinderpest	197	38	114	83	—	—
	Rabies	22	4	22	—	—	—
Northern Province	Rinderpest	861	285	436	162	131	132
Southern Province	Haemorrhagic Septicaemia	41	—	14	27	—	—
	Rabies	1	—	1	—	—	—
North-Western Province	Rinderpest	688	89	379	212	70	27
Central Province	Foot-and-mouth	47	—	2	44	1	—
	Rabies	1	1	—	—	—	1

T. M. Z. MAHAMOOTH,
Acting Deputy Director (Animal Husbandry), and
Government Veterinary Surgeon.

Peradeniya, November 1, 1945.

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METEOROLOGICAL REPORT, APRIL, 1945.

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	88·9	—0·1	73·1	—0·5	80	98	5·7	6·88	20	—
Anuradhapura	91·2	—0·1	73·8	—0·7	70	90	5·0	5·78	11	— 0·65
Badulla	84·4	+0·4	65·0	—1·3	79	94	3·8	5·27	15	— 1·73
Batticaloa	87·8	0	75·3	—1·5	82	93	5·4	0·28	4	— 2·02
Colombo	88·1	+0·3	77·0	+1·1	74	86	5·5	5·09	14	— 3·98
Diyatalawa	78·2	+0·4	60·4	0	72	86	5·6	6·39	14	— 0·15
Galle	86·3	+0·1	77·6	+0·9	80	84	4·8	2·24	16	— 6·47
Hakgala	73·2	—1·0	56·5	+1·5	72	80	5·2	6·22	16	— 0·76
Hambantota	88·4	+0·8	76·5	+0·2	82	88	5·6	2·26	10	— 1·60
Jaffna	88·8	—0·7	79·4	—0·6	70	85	4·8	1·50	6	— 0·73
Kandy	89·4	+1·3	69·2	—0·8	71	92	5·1	6·50	13	+ 0·01
Kurunegala	91·7	+0·6	74·4	—0·2	68	90	5·2	4·48	11	— 5·43
Lunuwila	88·4	—0·3	76·0	+0·5	80	93	5·6	6·32	14	— 0·52
Mannar	89·1	—1·3	77·3	—0·6	80	89	4·0	1·98	8	— 1·44
Nuwara Eliya	70·8	—0·6	50·1	+0·3	78	90	6·2	8·51	17	+ 3·53
Puttalam	89·0	—0·3	76·9	+0·9	76	88	4·7	4·42	4	— 0·46
Ratnapura	91·3	+0·3	73·4	—0·5	73	95	5·6	11·73	16	+ 0·16
Talawakele	77·7	+0·1	57·8	0	78	91	5·8	7·40	14	+ 1·10
Trincomalee	89·3	+0·3	76·7	—0·9	75	88	4·6	2·42	5	+ 0·29

Rainfall in April was below normal over a large portion of the Island. The larger deficits, of the order of 5 to 10 inches, were found in the south-western low-country and include 11·16 inches at Sunderland estate, 10·93 inches at Mayfair estate and 10·26 inches at Avissawella Hospital.

Rainfall was above normal in the north-eastern parts and in a small area among the central hills. The excesses were generally small, the highest being 5·79 inches at Pomparippu, 5·17 inches at Elephant Pass and 4·67 inches at Vavuniya P. W. D.

Monthly totals ranged from 5 to 10 inches over a large portion of the Island, stations recording the larger amounts being found chiefly in the Province of Sabaragamuwa. The highest totals were 16·33 inches at Kitulgala, 15·64 inches at Udugama and 15·52 inches at Gilimalay estate. Rainfall was below 2 inches along the east coast to south of Batticaloa. Tangalla in the south is the only station to send a nil return.

The only daily fall of over five inches was 5·10 inches at Udugama on the 18th.

Thunderstorm activity was in evidence during the greater part of the month. Particularly wet days were the 5th, and from the 9th to 19th.

Temperatures were on the whole about average. The highest recorded shade temperature was 98·9° at Ratnapura on the 30th, while the lowest air temperature was 44·9° at Nuwara Eliya on the 5th. Humidities were chiefly above average by day, and below average by night, and cloud amounts were in deficit. Winds were above average strength, the direction being variable.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

METEOROLOGICAL REPORT, MAY, 1945.

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	88·4	+1·8	74·3	—0·2	82	95	6·3	14·52	22	—
Anuradhapura	94·5	+4·5	76·4	+0.3	64	88	5·3	0	0	— 3·54
Badulla	87·4	+2·4	65·0	—1·6	70	94	3·0	3·90	9	— 0·79
Batticaloa	89·7	+0·5	77·6	—0·2	77	89	4·6	2·83	2	+ 1·04
Colombo	88·5	+1·8	78·0	+0·6	76	86	6·7	8·97	17	— 6·52
Diyatalawa	79·8	+1·3	60·5	—1·7	70	83	4·4	2·70	7	— 3·36
Galle	86·3	+1·6	79·1	+1·4	81	86	5·1	10·16	13	— 2·51
Hakgala	75·8	+3·0	56·8	—1·2	68	80	4·6	5·10	8	— 3·35
Hambantota	87·9	+1·6	78·1	+0·9	83	89	4·8	0·95	2	— 3·32
Jaffna	89·0	+1·1	82·4	+0·9	80	83	3·0	0	0	— 2·00
Kandy	91·6	+5·2	71·0	—0·1	68	88	4·9	0·78	3	— 6·79
Kurunegala	93·7	+5·0	76·9	+1·1	66	86	4·6	1·02	7	— 6·53
Lunuwila	88·9	+1·5	77·6	+0·6	79	93	6·2	2·50	15	— 9·43
Mannar	90·6	+1·2	81·5	+1·0	79	83	4·7	0	0	— 1·79
Nuwara Eliya	72·6	+2·5	49·5	—4·2	74	90	5·9	3·67	9	— 4·80
Puttalam	90·0	+2·0	79.8	+1·2	73	85	4·6	0·35	3	— 3·42
Ratnapura	90·7	+2·5	74·6	—0·2	79	95	5·8	9·25	15	—11·66
Talawakele	78·8	+4·0	58·5	—1·5	76	91	5·8	2·15	10	— 7·26
Trincomalee	95·9	+4·5	79·1	+0·4	66	78	3·5	0·60	2	— 2·63

Rainfall in May was exceptionally low, particularly in the south-western parts, where many stations which normally record 20 to 30 inches received only about a third of that amount. Highest monthly totals were 21·80 inches at Kokkawita Group, 20·71 inches at Gikiyanakande Estate and 20·31 inches at Pelenda, while a majority of stations in this region received less than 10 inches. In other parts of the Island the monthly totals were generally below two inches, there being no rain at all in the north-western parts and in Jaffna Peninsula.

At several stations in the south-west quarter this month's rainfall was the lowest on record for May. Thus 3·21 inches at Dunedin Estate is the lowest May total for this station for the last 62 years, the previons lowest being 3·80 inches in 1934. Similarly 7·77 inches at Avissawella Estate is the lowest for 48 years, 0·11 inch at Keenagaha Ella Estate, the lowest for 38 years, and 10·93 inches at Carney Estate, the lowest for 31 years.

There was accordingly a marked deficiency in rainfall in the south-western parts, deficits at a large number of stations exceeding 10 inches. The highest deficits were 21·52 inches at Carney Estate, 20·48 inches at Norton Bridge and 20·44 at Watawala.

The acuteness of the water shortage experienced in May was due to the fact that in certain parts of the Island, particularly in the southern and northern parts of the central hills and in the south-western foot-hills there was a continuous deficiency of rainfall for the last six months, *i.e.*, December, 1944, to May, 1945. Stations thus affected include Maskeliya, Watagoda, Hakgala, Galaha (Kirimetiya estate), Elkaduwa, Dehiowita (Digalla estate), Labugama, and Kalawana (Kokkawita Group).

Rainfall has been a little above normal at a few stations on the lee side in the Province of Uva and in Batticaloa District, the largest excesses being 3·64 inches at Viragoda, 3·00 inches at Ohiya and 2·84 inches at Walton estate.

There were twelve daily falls of over five inches for the month, the highest being 8·76 inches at Gonapenigala estate and 8·40 inches at Dolabodakanda estate on the 4th.

Although a moderate south-westerly pressure gradient was in evidence about the middle of the month, it showed no tendency to develop. The usual heavy rains in the south-west of the Island during May that mark the advent of the south-west monsoon were absent this year.

Temperatures were above average by day and generally about normal by night. The highest recorded shade temperature was 98·8° at Trincomalee on the 17th and 21st, while the lowest air temperature was 40·4 at Nuwara Eliya on the 9th. Day humidities were distributed on either side of average, and night humidities were slightly below normal. Cloud amounts were in deficit. Winds were mainly south-westerly.

Hailstorms were reported from Woodside estate on the 25th and Kabaragalle estate on the 30th.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

METEOROLOGICAL REPORT, JUNE, 1945.

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	86·2	+1·2	73·4	—0·8	84	95	8·0	20·93	22	—
Anuradhapura	92·0	+2·6	76·0	—0·3	63	86	6·8	1·83	3	+ 1·10
Badulla	85·3	0	63·9	—1·5	72	94	4·3	2·46	7	— 0·92
Batticaloa	93·5	+1·4	78·0	+0·5	61	78	6·0	0·06	1	— 0·83
Colombo	86·4	+1·2	77·7	+0·4	76	84	7·2	15·24	20	+ 6·58
Diyatalawa	76·6	—1·1	63·4	+0·4	64	76	5·6	4·77	7	+ 2·81
Galle	84·2	+0·7	77·3	0	85	89	5·6	11·24	17	+ 2·80
Hakgala	68·4	—0·3	57·9	—0·3	81	89	5·6	8·30	15	+ 1·69
Hambantota	87·7	+1·3	76·4	—0·4	78	91	6·0	2·67	13	+ 0·56
Jaffna	88·6	+2·2	81·6	+0·8	76	79	6·5	0	0	— 0·39
Kandy	85·9	+2·8	71·4	+0·2	74	85	7·8	6·38	16	— 2·45
Kurunegala	88·8	+2·5	76·1	+0·6	72	86	6·5	7·34	17	+ 0·55
Lunuwila	86·5	+1·0	77·4	+0·4	81	89	7·5	6·57	13	— 1·09
Mannar	89·5	+1·4	80·7	+0·2	76	80	5·8	0·06	2	— 0·30
Nuwara Eliya	66·1	+0·3	54·9	—0·7	81	88	8·6	8·94	21	— 1·49
Puttalam	87·2	+1·0	79·3	+0·1	76	82	6·0	0·84	4	— 0·56
Ratnapura	88·3	+1·9	74·9	+0·2	78	95	7·5	18·39	20	— 0·16
Talawakele	72·8	+2·2	59·5	—0·9	84	94	8·4	11·17	23	— 2·11
Trincomalee	93·5	+1·6	78·5	—0·4	64	65	5·6	0·55	2	— 0·38

In June again the rainfall was below normal over a large portion of the Island, the deficits on the south-western slopes of the hills being considerable. Thus, Sena wickrema Group had a deficit of 15·90 inches for the month, the total recorded being 19·22 inches against an average of 35·12 inches. Other large deficits were 15·63 inches at Watawala and 14·67 inches at Kenilworth estate. For a few stations in this region, like Maskeliya, Watagoda, Galaha and Dehiowita, this was the seventh successive month with deficient rainfall. In the northern and eastern parts of the Island too, the rainfall was below normal, but the deficits were less than two inches, because these regions normally receive very little rain in June.

Rainfall was above normal in the south-western low country, in the extreme south of the Island and in the lee of the hills. Largest excesses were found in or near Colombo, Aturugiriya recording 8·69 inches above average, Elie House 8·24 inches, Maligakanda 6·65 inches and Observatory 6·58 inches. Other large excesses were 6·79 inches at Kabaragalla estate and 6·40 inches at Udahena estate.

Although there was a large deficit in rainfall on the south-western slopes of the hills, it was this region that received most rain during the month, totals there exceeding 20 inches. The highest were 29·03 inches at Weweltalawa (Halgolla) estate, 23·53 inches at Dabar estate and 23·39 inches at Eheliyagoda Group. There was a gradual decrease in rainfall towards the north and the east, monthly totals outside the south-west quarter being generally below two inches. A large portion of the Northern Province, and some parts of the Eastern Province received no rain at all.

There were altogether 58 daily falls of five inches or over for the month, all on the 6th. Outstanding figures were 9·23 inches at Weweltalawa (Halgolla) estate, 8·70 inches at Padupola, 8·45 inches at Blackwater estate and 8·42 inches at Kenilworth estate.

There was only a weak south-westerly pressure gradient at the beginning of the month. A considerable and sudden steepening of this gradient about the 6th resulted in a spell of heavy rainfall in the south-west of the Island from the 6th to 9th, accompanied by unusually severe squally conditions on the west coast. During this period the recording anemometer at the Colombo Pilot Station frequently registered westerly winds of gale force (38 miles per hour) and over, wind speeds of between 50 and 60 m.p.h. being attained on several occasions. By the afternoon of the 10th the weather conditions had moderated appreciably. For the rest of the month, only generally light rain was experienced.

Temperatures were again above average by day and generally about normal by night. The highest recorded shade temperature for the month was 98·3° at Trincomalee on the 21st, while the lowest air temperature was 48·0° at Nuwara Eliya on the 3rd. Humidities were generally below average, and cloud amounts in deficit. Winds were south-westerly.

A hailstorm was reported from Keenakelle estate on the 4th.

D. T. E. DASSANAYAKE,
Superintendent Observatory.